GEOLOGICAL SURVEY OF KENTUCKY.

TIMBER AND BOTANY.

B

CALIFORNIA STATE
MINING BUREAU,
SAN FRANCISCO.

COMPRISING SEVEN REPORTS ON THE FORESTS AND BOTANY OF DIFFERENT PARTS OF THE STATE.

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PREFACE TO SECOND EDITION (NEW SERIES).

It being necessary to publish a new edition of the Reports of the Geological Survey, it is thought proper to change the arrangement of the reports in the several volumes. This is advisable in order to bring together in one volume the several reports relating to a given subject or locality. In the first edition (second series) the volumes were made up of reports, regardless of subjects treated, and in order to learn all that may be published of a locality, the reader must examine several volumes. For instance, the reports on the iron ores and the iron manufacture of Greenup, Carter, Boyd, and Lawrence counties is in volume 1, and the Report on the Geology of the above named counties is in volume 2. The Chemical Reports and the reports on the Timbers are scattered through four volumes. This arrangement of reports could not have been avoided in the early history of the Survey without a delay in the publication of the volumes. It is thought that the arrangement in this edition will more fully meet the wants of the public, and will render the reports more valuable.

The first volumes of this edition will comprise the following: Chemical Analyses, Reports on the Eastern Coal Field; Reports on the Western Coal Field; Reports on Timbers. Other volumes will be published from time to time, preserving the same order of grouping reports. Some of the preliminary reports contained in the first edition have been omitted, in order that there may be no duplication when the final reports are published. I am of the opinion that enough preliminary or reconnoissance work has been done by the Survey, and the work will be directed with a view of securing (so far as the means will permit) complete reports on the geology, soils, timbers, etc., of the various regions

studied. As the stereotyped plates of the omitted preliminary reports are preserved, new editions may be ordered should there be a demand for them. A change has also been made in the size of the volume by decreasing the size of the margin, which, it is thought, will make the volume a more convenient size, both for library use and for sending through the mails.

JOHN R. PROCTER,
State Geologist.

GEOLOGICAL SURVEY OF KENTUCKY

N. S. SHALER, DIRECTOR.

REPORT ON THE FORESTS

OF

GREENUP, CARTER, BOYD & LAWRENCE COUNTIES.

BY N. S. SHALER AND A. R. CRANDALL.

REPORT ON THE FOREST TIMBER

OF

GREENUP, CARTER, BOYD & LAWRENCE COUNTIES.

INTRODUCTION.

The questions, both scientific and economic, which are connected with our forests, are at once numerous and of very great value. The student finds himself led to the study of the laws determining the growth and succession of the trees; the way in which they are connected with the underlying rocks; the history of their creation or appearance in their present places, and many other similar matters. Some of this class of questions are purely scientific; that is to say, they do not connect themselves with any immediate monetary result. The plan of this Survey contemplates their study quite as much as if they were of pecuniary value; but these scientific results will find their place in the memoirs of the Survey which will be specially devoted to purely scientific matters, while the reports are to be given to the questions of economic value. It must not be supposed, however, that the separation of these two classes of treatises will be absolute; science is so far the handmaiden of the arts that it must always go with them if they are to retain their best value. The reader will, for instance, notice, that along with the common names of the trees in this report are given also the scientific names of the species. In no other way would it be possible to make it certain just what sort of tree was meant by the name; for the familiar name of a tree may vary from place to place, while the scientific name is the same for all countries, and enables us to designate the given kind of tree, so that all botanists can make sure of it. The way in which the timber is distributed, with reference to the underlying rock and the quality of the soil, are also

questions at once scientific and economic in their value. These are only a small part of the questions where the scientific and the practical values come together, but they serve in a small way to show the essential connection between the two.

Hitherto all the descriptions given of forest timber have been very indeterminate, as far as concerns the size and number of the different kinds of trees on given areas. In laying out a plan for the work of the Kentucky Survey, it seemed desirable to take an account of our forests in such a fashion that it would be possible to obtain precise statistics concerning every important feature capable of being accurately measured. It was obviously necessary to count the number of trees to the acre on several different exposures in each district, taking account of the different species, so as to show their relative proportions and average size. Mr. Crandall has been charged with the execution of this plan, and he has perfected it in several essential particulars. His method of indicating the distribution of the species of trees on different slopes of the same hill is entirely original, and expresses the facts in an admirable manner. It is in the plan of the Survey to carry this same system of delineation over the whole of the State, with a view to give a record of the present condition of our forests, in order that their changes in coming time may be determined, and especially that their economic value may be properly appreciated. I am satisfied that, by properly husbanding our timber resources, they will in fifty years become one of the most important of the varied sources of wealth to our State. A large part of the eastern coal-field of Kentucky is not tillable land. The lofty and rugged ridges between the valleys are natural nurseries of timber. While they will not serve for other forms of cultivation, they will yet do admirably for the raising of many of the most valuable woods for our various arts. So large a part of the Valley of the Ohio is arable land, that the future sources of timber for its use are very limited. They will be found in the lofty ridges of the Apalachian Mountains where the steepness of the slopes will forbid plow tillage.

I deem it quite likely that within the time of the next generation these hill lands will become as valuable for timber-raising as the average lands of the valley are for other forms of culture. They are naturally suited to all the most valuable woods of the Mississippi Valley. At the present value of black walnut, an acre of this timber forty years old, growing as thickly as it is able to stand, should be worth several hundred dollars; of hickory and locust of second growth the value is about as great. There are few crops of the ordinary soil which will give as great average returns when labor and interest are deducted. A very great advantage in our Kentucky forests is the comparative immunity from fires. In most valuable timber regions this danger is so great as to reduce the value of such lands as investments. In many thousand miles of travel through the timbered districts of Kentucky, I have never seen an acre of forest seriously damaged by fire. In the present state of our American life, when men are hardly willing to wait for the yearly harvests to mature, it seems almost too much to hope for the far-seeing thrift that will look forward to fruits to be gathered at the end of forty years; yet these enterprises that take hold on a distant future will become more attractive, with a growth of capital and an increase of confidence in life. But in fact a large part of the value of such growths as our forests would give when artificially planted would be immediate; at five years young hickories have a value; and the trees removed by trimming out each year, should pay an interest on investment. The black locust becomes valuable in ten years, or nearly as soon as a pear orchard, and for thirty years thereafter should give a steady supply of timber. With each succeeding year these woods become more and more valuable as the original forests become stripped of their scanty supply. The best black walnut is already priced with mahogany in Europe, bringing several dollars per cubic foot. The abundant water-ways of the Ohio Valley will always make its regions of permanent forests of peculiar value.

There is another and most important reason for retaining the forest covering of our eastern hills. The surface of that

country is so rugged that nearly seven eighths of its area lies in slopes of great steepness. If stripped of their timber, the water will not lie on these slopes much longer than on the house tops.

By the forest covering a large part of the water is retained as by a sponge, and is allowed to filter away slowly into the streams. A heavy rain of say five inches in depth, falling within say two days, will have at least one half of the precipitated water retained for some days in the mat of decaying leaves of the forest, which would otherwise be precipitated at once into the streams. To strip away the forests is to double the amount of water thrown at one stroke into the rivers. A glance at the map of the Big Sandy or Chatterawha Valley will show that this stream has a great many branches, and gathers the water from about five thousand square miles of mountainous country. Every part of this area is made up of narrow valleys and steep hillsides. As it is, the floods of the Lower Sandy rise to about fifty feet above the low-water stage of the river, and are formidable in their violence. If the country should ever become stripped of its timber, the consequences would be disastrous in the highest degree. Some of the valleys of a similar character in Europe, which have been recklessly stripped of their timber, have become almost devastated by the violence of the floods. There are several such cases in France where the soil has been in good part stripped away since the timber was removed, and the government has been compelled to intervene in order to restore the forests. When this restoration has been accomplished, an immediate change for the better has been brought about. Thus we see that there are two good reasons for endeavoring to retain the forests of the Big Sandy Valley. Firstly, that they may remain a source of supply for valuable timber, which each year must enhance in price on account of the increasing population of the Ohio and Mississippi Valleys; secondly, on account of the safety of the agricultural and mining interests of the region which must be located along the valleys, and thus be in great danger from any increase of the floods which now sweep them.

It may be urged in addition that the best interests of this valley demand that the streams, even to their second and third branching, should be used as a means of bringing out the mineral and timber stores. This will require the extensive use of locks and dams; and these structures, already difficult to construct on account of the violence of the floods, would become quite impossible if their force is increased, as it will be by the destruction of the forests. The mineral region of Eastern Kentucky has a precious heritage in its forests, ores, and coals. All the skill of legislation, and all the discretion of private enterprise, should be directed to securing the best products from these resources, avoiding destructive waste. This cannot be done except by preserving the forests without great reduction from their present area. If the State, or the counties thereof, still own large tracts of forest timber, it would be clearly in the line of true policy to retain those areas as public domains in the interest of coming generations. Throughout Switzerland and other parts of Europe the communal forests, rarely large in area, are the most precious of the public domains. From them the citizens derive in many cases sums so large as to form a considerable element in their private revenues. Every county in our mountain districts that will put aside as public land ten thousand acres of forest, worth to-day as many dollars, will, at the end of a century, have a princely domain. There is, in a word, no gift that the present generation can make to the future so precious and so noble as untouched areas of our magnificent forests. For us it requires little forbearance to spare what will be to them a most precious heritage.

N. S. SHALER.

INTRODUCTORY LETTER.

Professor N. S. SHALER,

Director of the Kentucky Geological Survey:

The accompanying brief report on the Timber of Eastern Kentucky is made up from observations made during the progress of the geological work in the field which it includes. The work on which it is founded is, therefore, secondary, and somewhat unsatisfactory in details. It may serve, however, as an introduction to a study of the forest growth of this section.

A. R. CRANDALL,
Assistant Ky. Geological Survey.

REPORT ON THE TIMBER GROWTH

OF

GREENUP, CARTER, BOYD & LAWRENCE COUNTIES,

IN EASTERN KENTUCKY.

BY A. R. CRANDALL.

The timber of Eastern Kentucky might, from its suitableness to meet two classes of wants, be considered with reference to use in iron-making, or as fuel; and with reference to the uses which give rise to a demand for lumber and other forest products. Following this division of the subject, a very large proportion of the forest growth would fall under the latter heading. But as practically the purpose to which it will be turned depends not so much on the character of the timber itself as on the character of the demand for it—a demand shaped largely by such accidents as the facilities, or want of facilities for transportation—it will be as well, perhaps, to treat the subject in a more general way, or simply as to the kinds of forest trees and their distribution.

The difficulties which now stand in the way of bringing the more valuable timber of Eastern Kentucky into market, inevitably turn it to furnace use where furnaces are within reach; and where neither furnaces nor marketing facilities give immediate value to the forests, the timber that is not burned in the ordinary process of clearing and fencing land, or that is not wantonly destroyed, awaits the developments of time only to determine whether the more valuable part shall be turned to use in a wide range of wood manufactures, or consumed indiscriminately with the rest in the smelting of the ores which abound in this region.

The subject may be conveniently divided, however, so as to present it with reference to a number of questions which naturally arise with the study of the forest growth. After the occurrence of species, the number and size of the various trees, of scarcely less importance is their geographical distribution; the effect of varying surface conditions, as found in a hilly country, and also the effect of varying exposure. Not altogether foreign to an economic view of the subject is the question of geological distribution, or the assemblages of species on particular geological formations. It is possible that generalizations may be reached by which the forest growth will give an important clue to geological formations. A sufficient number of observations have not yet been made to warrant such generalizations for this field. But it is important that the facts should be so recorded as to facilitate a careful study in this direction, when additional data shall have been gathered from a wider range of country. This branch of the subject will, therefore, be left for future treatment.

No complete list of the kinds of trees found in this section can yet be given, as, indeed, only a beginning has been made in so considerable a task as is involved in even a preliminary study of the forest trees of so extended and so varied a field. Still enough has been done to foreshadow good results, both economic and scientific.

In the presentation here made, it is taken for granted that the value of the different kinds of wood for the various purposes to which they are suited, is too well known to require special mention. For the present also the question of facilities for transportation and marketing will be left to the enterprising, in the hope that a simple statement of facts will serve equally well to encourage practical solutions of the question to the advantage of all parties interested.

The accompanying tables show approximately the relative abundance of the more common species of trees. These tables are made up from studies made partly by Mr. J. A. Monroe and partly by myself. The timber on an acre (estimated or paced) is included in each observation; and when

practicable, observations were made so as to give an account of the number of trees representing each species. First, in the bed of the valley, including also, in most cases, about an equal area of slope; second, the side hill at that part of the slope which appeared on all accounts to be most nearly a medium between hill-top and valley; and third, the top of the hill or ridge, including more or less slope. The tables are so arranged as to give the relative abundance of different species for a number of localities at these levels. The per cent. of each species in a given locality, the per cent. of each species at the several levels for all localities included, and the per cent. of each species in the whole timber growth of the country, are also given; the counts chosen being regarded as representative for this part of Eastern Kentucky. It should be remarked here that in some instances an unusual growth of certain species, from some cause to which it is important to call attention, has been included; but with such qualifications as are made in the general mention of species, the tables will be found reasonably correct.

CALIFORNIA STATE
Mining Bureau,
SAN FRANCISCO.

TABLE I.—Old Forest Growth.

SPECIES.	*Near head of Irish Creek, Lawrence County.*				*Blain, 1 mile above mouth of Cherokee Creek, Lawrence Co'ty.*				*Little Fork of Little Sandy, Graham Hill, Carter Co'ty.*				*Various localities in Carter, Lawr'ce, and Boyd.*				*Slash Branch Laurel Furnace Land, Greenup Co.*			
	Per cent. for locality				Per cent. for locality				Per cent. for locality				Per cent. for locality				Per cent. for locality			
	Valley (horizon of C. No. 2)	Hillside (horizon of No. 3 C.), 100 to 150, S. W. ex.	Top of hill (horizon of C. No. 7), 250 to 300		Valley (horizon of No. 1 C.), east side	Hillside (above C. No. 3), S. E. exposure	Top of hill (horizon of C. No. 7), 300 to 350		Hillside (horizon of L. ore), 150 to 200	Ridge (horizon of C. No. 8), 300 to 350 above drainage			Laurel Fork of Blain (Cong. S. S.), valley	Head of Lost Fork (Mahoning S. S.), 200, W. exposure	Divide between Chadwick's and White's creeks, 350		Valley (horizon of Waverly S. S. and S.)	Hillside (horizon of Cong. S. S. and Sub-carb. L.), E. ex.	Hill (above Cong. S. S.)	
White oak	14	20	25	.224	6	25	2	.140	13	35	.	.157	14	3	13	.140	12	17	8	**.177**
Black oak	.	25	10	.133	.	3	10	.055	5	11	20	.118	.	4	12	.075	3	6	10	**.091**
Chestnut oak	.	.	25	.080	.	9	48	.243	.	5	72	.252	.	4	30	.159	.	4	17	**.100**
Post oak	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**. .**
Other oaks	.	.	6	.023	.	2	1	.013	.	1	.	.003	.	5	.	.023	.	3	.	**.014**
Beech	25	.	.	.095	51	3	.	.229	37	10	.	.154	16	.	.	.075	14	11	.	**.120**
Maple	10	.	.	.038	4	5	3	.051	26	2	.	.092	25	3	.	.131	4	3	.	**.033**
Chestnut	.	.	.	.	.	6	.	.026	4	.	.	.013	.	4	6	.045	4	.	12	**.077**
Hickory	.	25	15	.152	.	12	21	.140	7	16	4	.095	.	5	4	.042	10	8	3	**.100**
Yellow poplar	.	.	.	.	3	4	.	.030	6	3	.	.029	.	6	.	.028	7	4	8	**.091**
Gum	3	.	.	.011	.	8	.	.034	3	6	.	.029	4	5	2	.057	2	2	3	**.033**
Ash	.	.	.	.	.	2	.	.009	1	2	.	.010	4	3	.	.033	.	1	.	**. .**
Linden	.	.	.	.	.	.	.	.	1	.	.	.003	4	8	.	.056	4	.	.	**.019**
Sycamore	5	.	.	.019	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	**.043**
Buckeye	.	.	.	.	2	.	.	.009	.	.	.	.	.	.	.	.	3	.	.	**.014**
Elm	.	.	.	.	.	.	1	.004	.	.	.	.	2	2	.	.019	3	.	.	**.014**
Black walnut	.	.	.	.	2	.	2	.017	1	.	.	.003	.	4	.	.019	2	.	.	**.010**
White walnut	.	.	.	.	.	.	.	.	.	.	1	.003	.	.	.	.	.	.	.	**. .**
Hemlock	18	.	.	.068	.	.	.	.	.	.	.	.	15	.	.	.070	.	6	.	**.029**
Pine	.	31	10	.156	.	.	.	.	.	.	13	.043	.	.	7	.033	.	.	6	**.029**

TABLE I.—Old Forest Growth—Continued.

SPECIES.	*Raccoon Furnace Lands, Greenup Co.*				*East Fk., near Cannonsburg, Land of V. Calvin, Boyd County.*				*Ellington's, Bear Creek, Boyd County.*				**Per cent. for all localities**	**Per cent. for all localities—top of hill**	**Per cent. for all localities—hillside**	**Per cent for all localities—valley**
	Per cent. for locality				Per cent. for locality				Per cent. for locality							
	Valley (horizon of No. 1 C.)	Hillside (between C.'s No. 2 and No. 3, 200)	Top of hill (horizon of C. No. 3), 300 feet above drainage		Valley (horizon of No. 6 C.)	Hillside (horizon of No. 8 C.), 100 to 150 S. E. ex.	Top of hill (horizon Mahoning S. S.), 300		Valley (horizon of No. 8 C.)	Hillside (horizon of Mahoning S. S.), 150 to 250	Top of hill (above Mahoning S. S.), 300 to 350					
White oak	14	17	13	.187	17	19	12	.195	15	19	12	.152	.149	.237	.129	**.171**
Black oak	12	11	17	.170	12	10	9	.126	11	14	20	.149	.061	.129	.164	**.117**
Chestnut oak	.	.	.		1	7	8	.065	.	.	.	.	.	.044	.297	**.112**
Post oak	.	.	.	.	.	3	4	.028	.	.	8	.026	.	.	.018	**.007**
Other oaks	.	8	14	.090	8	7	5	.081	4	4	10	.060	.017	.046	.055	**.038**
Beech	9	12	2	.089	23	.	.	.093	21	9	.	.100	.278	.069	. .	**.119**
Maple	3	3	.	.026	6	9	.	.061	4	5	.	.030	.116	.046	.005	**.057**
Chestnut	.	4	9	.055	2	3	2	.028	4	4	6	.046	.020	.032	.053	**.035**
Hickory	4	4	9	.072	.	.	.	.	.	9	10	.063	.030	.120	.100	**.082**
Yellow poplar	13	.	4	.072	4	7	6	.069	12	14	5	.102	.064	.058	.035	**.052**
Gum	.	3	8	.047	6	3	.	.037	4	3	4	.036	.031	.046	.026	**.034**
Ash	.	.	.	.	.	.	.	.	.	4	4	.026	.007	.018	.006	**.010**
Linden	3	2	.	.021	.	.	.	.	6	.	.	.020	.026	.015	. .	**.014**
Sycamore	8	.	.	.034	13	.	.	.053	9	.	.	.030	.062	. .	. .	**.022**
Buckeye	7	.	.	.030	.	.	.	.	3	.	.	.010	.021	. .	. .	**.007**
Elm	3	4	.	.030	14	8	.	.089	4	.	.	.013	.037	.021	. .	**.020**
Black walnut	3	6	.	.038	3	.	.	.012	7	5	.	.040	.026	.023	.003	**.017**
White walnut	.	.	.	.	2	.	.	.008	3	.	.	.010	.007	. .	.002	**.003**
Hemlock	.	.	.	.	.	.	.	.	.	.	.	.	.047	.009	. .	**.019**
Pine	.	.	8	.034	.	4	9	.053		9	17	.086	. .	.067	.106	**.056**

Table I is made up from counts of old forest trees. Table II of second growth.

It will be noticed that the white oak (*Quercus alba, L.*) has a wider range and a greater development in numbers than any other species. In size, it ranks with the largest of the hard wood trees, often reaching a diameter of three and a half feet. It is probable that, along with its adaptation to a wide range of surface conditions in its growth, there is some variation in the quality of the wood; but it occurs in nearly all valleys, and well up on the slope of most hills, in such size, and apparently of such quality, as is usually sought after for the purpose for which it is most valued. In many instances of growth on a southern or southwestern exposure, it is comparatively small in size. The same may be said of the tops of many hills; but the average size and height is such as to warrant a very liberal estimate, wherever the forest remains, for that alone which is available for lumber. In point of number the white oak makes up about seventeen per cent. of the forest growth. Its large average size gives it still greater prominence.

The black oak or yellow bark oak (*Quercus tinctoria, Bertram.*) has a range not unlike the preceding. It also constitutes a large per cent. of the forest growth. A considerable number of smallish trees, which doubtless represent to some extent a second growth, are included in most of the observations of Table I, giving undue prominence to this species. It will be noticed that, in the table of second growths, it is still more prominent, showing an adaptation to a wide range of surface conditions. It would seem from these observations that the black oak is less fitted by the strength and durability of its wood to attain great age than is the white oak, though instances are not wanting in which it reaches a size equally as large.

The chestnut oak (*Q. castanea?*) often predominates on the ridges, extending its range downward in a rapidly decreasing proportion, rarely being found in the valleys. In this section, while it frequently attains a large size, it is generally inferior in height to the white or black oak. This is doubtless owing

partly to exposure to sweeping winds, and partly to the rocky character of the ridges on which it abounds. Further back in the country, and especially as noted on Laurel Mountain, where it is abundant over the greater part of the slope, the chestnut oak is not inferior in height to any of the oaks. While this is suggestive as to the cause of the disparity in height noted in the field covered by this report, it also gives rise to questions relating to its distribution, questions which may, however, with the suggestion, be left for further investigation.

The post oak (*Q. obtusiloba, Michx.*), a tree of medium size, is less abundant. It is found in various exposures in scattered growth. Its wood is very close, hard, and durable.

The other oaks noted, but which, for want of accurate distinction in some of the counts, are thrown together in the tables, are the red oak (*Q. rubra, L.*), which is abundant in many places. It reaches dimensions scarcely less imposing than those of the white and black oak.

The Spanish oak (*Q. falcata, Michx.*), which occurs mostly as second growth, but also as large trees, especially in Lawrence county.

The laurel oak (*Q. imbrecaria, Michx.*) also occurs in small size at a number of points in each county. Along Blain, and especially for some distance above the Falls, trees of large size are found.

The black jack or barren oak (*Q. nigra, L.*) occurs in various exposures, but mostly on the more barren and rocky slopes.

The oaks constitute about forty-two per cent. of the forest trees.

The beech (*Fagus ferruginea, Ait.*) ranks with the chestnut oak in abundance; but in distribution it is quite unlike that tree, being found mostly along the foot of the hills. It sometimes becomes prominent well up the slope, and not unfrequently occurs in scattered growth along the highest ridges. It often shows a diameter of three feet, and is on many accounts one of the most interesting trees in this section.

The maple is also abundant in some valleys, having a range not unlike the beech. The sugar tree or rock maple (*Acer*

saccharinum, Wang.) makes up a very large proportion of the maples. Along the banks of streams the white maple (*Acer-dasycarpum, Ehrhart*) is common, while an occasional red maple (*A. rubrum, L.*) is found, as also the ash-leaved maple (*Negundo aceroides, Mœnch*). The latter tree affords a wood that is perhaps better suited for making small patterns or models than any other of our native trees. The numerical proportion of the maple, as of all those trees which have their greatest development along river and creek bottoms, has been greatly reduced by the clearing of land. Good sugar orchards have to be sought for the most part in unsettled localities.

The chestnut (*Castanea vesca, L.*) is found in all localities, and in such size as to give it a prominence much greater than is shown by its per centage in the tabular view. In the table of second growths an increased proportion is shown. The dwarf chestnut or chinquapin (*C. pumila, Michx.*) has not been noticed in this section.

The hickories are represented by many large trees. Table I, however, includes a considerable number of smallish trees, giving, perhaps, undue prominence to the hickories; but this fact is largely offset by the great number of small hickories, which are a common feature of the undergrowth, and which afford a large supply of hoop-poles.

The yellow poplar, the tulip tree or whitewood (*Liriodendron tulipifera, L.*), occurs in all localities. It ranks in size above all the other trees of Eastern Kentucky, unless the sycamore be excepted, which occasionally reaches immense size. The tulip tree ranges in size from two to five feet in diameter, having a cylindrical trunk of great length. The young tree is highly ornamental, both in form and foliage. Few small trees of this species are included in Table I, yet in number of individuals it makes up about five per cent. of the forest growth.

The gum tree or black gum (*Nyssa multiflora, Wang.*) grows in all localities, and is represented here and there by a tree at all levels in nearly all exposures. Its value as a suitable wood for wheel-hubs, and for other purposes for which a cross-fibred

wood is desirable, will doubtless give rise to a demand for this now somewhat despised tree.

The ash (mostly *Fraxinus Americana, L.*, or the white ash, but including two or three other species of rarer occurrence) is represented by some trees of large size, but by more of a smallish size, which may be regarded as a second growth in the old forest.

The linden or basswood is abundant in some shaded valleys and on some moist slopes. In the tables it falls below its proportional number, as do some other species, from the difficulty of selecting average localities for all the species.

The sycamore (*Platanus occidentalis, L.*) occurs along the river and creek bottoms as a large tree of irregular growth, sometimes reaching a diameter of six or seven feet. In second growth timber it is sometimes found along the slopes of hills, and even on the tops of ridges, as along the ridge road from Ashland to Clinton Furnace, 350 feet above drainage.

The buckeye (*Æsculus flava, Ait.*) occurs as a large tree low down in the valleys. In second growth it occurs higher up the hillsides, but somewhat rarely.

The elm is represented by several species—the *Ulmus Americana, L.*, or the American elm; *U. fulva, Michx.*, slippery elm, and *U. alata, Michx.*, winged elm. The first named being the common species. The others occur here and there as trees of moderate or small size.

The walnut trees (*Juglans nigra, L.*), black walnut and (*J. cinerea, L.*) white walnut or butternut, have about the same range, the former being most abundant. The value of this wood seems to be little understood in this section, as it is often used for fencing, or wantonly destroyed. It does not occur in great numbers in any particular locality, but is found along the hillsides and in the valleys of the smaller streams scattered among the other trees. Occasionally trees of great size are met with, as notably on Rock-house Branch of Jourdan's Fork, in Lawrence county. In the second growth the walnuts both show an increased per centage. It would certainly prove a wise policy to encourage the growth of both; but particularly of the

black walnut, the demand for which is rapidly outrunning the supply.

The hemlock or hemlock spruce (*Abies Canadensis, Michx.*) is restricted in its range to shaded ravines and rock-bound creeks. Cliffs and ledges of coarse sandstone, and particularly of the conglomerate sandstone, when near the bed of the creek, are often covered or surrounded by an almost exclusive growth of hemlock and laurel—trees and shrubs which make slight competition for the more open soil. The hemlock is not limited to coarse sandstone formations, however. It is found, less frequently, clinging to or growing along ledges of limestone, as on Tygert's creek, where it is associated with cedar, and also covering the steep faces of the Waverly sandstone, as exposed along some of the streams west of Tygert's creek.

The pines are represented by several species; the yellow pine (*Pinus mitis, Michx.*) being the common species. The white pine (*P. strobus, L.*) occurs on Buffalo creek, in Carter county. It is represented here by a few scattered individuals only. The scrub pine (*P. inops., Ait.*) is more common in second growth, as on the hills around Louisa.

The red cedar (*Juniperus Virginica, L.*) grows in many localities low down in valleys or on bluff-like hills; but it has a much more marked development along the outcrop of the subcarboniferous limestone than elsewhere.

Besides the trees mentioned in the tables, there are others of less common occurrence, as also a number of small trees and of shrubs, which, though they do not largely affect the character of the old forest, are worthy of mention.

The poplar (*Populus grandidentata, Michx.*) occurs at several points on low ground.

The persimmon or date-plum (*Diospyrus Virginiana, L.*) is found in nearly all localities. Attention has been called to this tree by a number of writers as one likely to repay with valuable fruit an intelligent effort to cultivate and improve it.

The cherry is represented by two species (*Prunus serotina, Ehrhart* and *P. Pennsylvanica, L.*), the former occasionally

growing to good size, as instanced by the beautiful tree in front of Mr. Scott's house, at Olive Hill.

The common locust (*Robina pseudacacia, L.*) occurs without apparent regard to level or exposure.

The honey locust (*Gleditschia triacanehos, L.*) is limited to the lower grounds.

The cucumber tree (*Magnolia accuminata, L.*) is found rarely in Carter and Lawrence counties. It is a large tree, and equally as valuable for lumber as the tulip tree.

The umbrella tree (*Magnolia umbrella, Lam.*) occurs in great numbers on the waters of the Chatterawha or Big Sandy, also on some of the tributaries of the Little Sandy. It is a small but interesting tree, and one that is very desirable for purposes of shade and of ornamentation. In Eastern Kentucky it grows mostly along the streams. In Tennessee I have noticed it covering a hill to the exclusion of other trees. It is likely, therefore, that no difficulty would be experienced in transplanting it to higher land and dryer soil.

The water birch (*Betula nigra, L.*) is abundant on the banks of some of the larger streams, like Tygert's creek, the Little Sandy, and Blain.

The black birch (*Betula lenta, L.*) was noted as a small tree at a number of points.

The hackberry (*Celtis occidentalis, L.*) has an occasional representation of moderate size.

The sweet gum (*Liquidamber styraciflua, L.*) was noted at a number of points along the border of Greenup and Lewis counties as an occasional tree of small growth. It has a considerable development, both in number and size, on Lick creek, near Louisa, in Lawrence county.

The mulberry (*Morus rubra, L.*) is found at wide intervals in the valleys and on the hillsides. A spreading tree, often of considerable size, and always bearing an abundance of rich fruit in its season.

The willows frequently border the streams with various growths, from the shrub to the large tree.

The catalpa (*C. bignonoides, Walt.*) is found both on cultivated and on wild lands. Whether native in the latter instance is uncertain from observations in this field.

The hop hornbeam or lever wood (*Ostrya Virginica, Willd.*) occurs only rarely and in small size.

Water beech (*Carpinus Americana, Michx.*) is abundant everywhere, sometimes reaching eight to ten inches in diameter. It is a very close-grained wood, and may be made valuable for turning by boiling or saturating with water before drying.

The dogwood (*Coruns florida, L.*) is also abundant throughout. It rarely reaches a diameter of ten inches, but it grows a more regular and shaft-like trunk than the preceding, while it is equally close-fibred, and more readily seasoned for use.

The Juneberry or service berry (*Amelanchier Canadensis, Torr & Gray*) has an occasional representative.

Sassafras (*S. officinale, Nees.*) is common, and usually associated with the sour tree or sorrel tree (*Oxydendrum arboreum, D. C.*)

The pawpaw grows in dense thickets along the foot of most hills, extending up ravines and reaching up hillsides in lessening numbers. It is sometimes found near the tops of hills 250 to 300 feet above drainage.

American holly (*Ilex opaca, Ait.*) is usually found associated with hemlock and the laurels in rocky and broken areas.

The redbud (*Circis Canadensis, L.*), the black haw (*Viburnum prunifolium, L.*), spicewood (*Benzoin oderiferum, Nees.*), hazelnut (*Corylus Americana, Walt.*), and the witch hazel (*Hamamelis Virginica, L.*) are occasionally met with.

Sumach (*Rhus copalina, L.*), alder (*Alnus serrulata, Ait.*), and several species of thorns, are more common. The hawthorn occurs near Ashland, probably introduced. Leatherwood (*Dirca palustris, L.*) has been noted at several points west of Tygert's creek. The crab apple and the wild plum sometimes make up a part of thickets, which appear to be a wild growth.

Grapevines, the climbing bittersweet, the Virginia creeper, as well as the poison ivy, frequently overrun the smaller trees

and shrubs, or cling to the larger trees. Other climbing vines and many small shrubs might be added, but may well be reserved for a more extended catalogue of plant species.

SECOND GROWTH.

The character of the timber growth, which springs up where old forests have been removed, has been made the subject of some investigation—the furnace lands affording an opportunity for comparing the second and also the third growth with that of the original forest. There seems to be very little difference between the second growth and the third as to the species represented, or as regards the numerical proportion of the species. It is deemed sufficient for the present purpose to present a tabular view of such observations as appear to be representative of the second growth in this section. Table II affords an easy means of comparison with the original growth of timber.

It will be noticed at once that the assemblage of species is very similar to that of the old forest. A little closer comparison will show that the changes indicated are such as to add to, rather than detract from, the value of the second growth. This is equally true, whether regarded as fuel for the furnace or as growing timber for future market.

Those trees, which grow chiefly on bottom lands and near creeks, show a falling off in number for the reason that the lands at this level are so generally under cultivation as to limit observations to the slopes and the tops of hills.

It is well known that in many localities the character of the second growth is quite unlike that of the original forest; and often the new growth is made up of species so inferior for fuel, or any of the purposes for which wood is in demand, that it is of little economic value. An interesting and important field for investigation is opened here; but for the present it will suffice to call attention to the importance of the fact where the second natural growth and the succeeding ones are not inferior to the old forest growth. This is readily seen from an illustration furnished by the locality in question. Notwithstanding

the abundance of mineral coal, the value of charcoal iron is such as to warrant the building of charcoal furnaces where both timber and ores are abundant; and as the consumption of timber in iron-making rapidly sweeps away the old forest, it is of no small importance that nature instantly sets about replacing in kind what is consumed from year to year by the furnace.

The statistics of Mt. Savage Furnace, which may be taken as a representative instance, show a consumption of about twelve thousand cords of wood per year, or for an average blast of a little more than three thousand tons iron product.

Allowing thirty to thirty-five cords of wood to the acre—a low estimate for hill and valley—gives a yearly decrease in forest area of from three hundred and fifty to four hundred acres. From the best information obtained in this furnace region, it appears that from twenty-three to twenty-five years' growth is required to give an average of thirty to thirty-five cords of wood per acre. From this it appears that a tract of nine to ten thousand acres is sufficient for the establishment of a perpetual charcoal furnace of ordinary capacity.

TABLE II.—Second Growth.

SPECIES.	*Hunnewell Fur. Lands, 23 years' growth.*			*Star Fur. Lands, 24 years' growth.*			*Buena Vista Furnace Lands, 22 years' growth.*			*Buena Vista Furnace Lands, Boyd County.*		
	Hillside (horizon of No. 3 C.), 100 to 150	Top of hill (horizon of L. ore), 200 to 250	Per cent. for locality	Hillside (horizon of C. No. 7), 100 to 150 above drainage	Top of hill (horizon of No. 8 C.), and above 250	Per cent. for locality	Hillside (horizon of L. ore), 75 to 150	Top of hill (horizon of No. 8 C.), 150 to 250	Per cent. for locality	Hillside (horizon of No. 7 C.), 100 to 200	Top of hill (horizon of No. 8 C.), 250 to 300	Per cent. for locality
White oak	30	34	.194	40	46	.248	38	36	.214	20	34	.172
Black oak	36	40	.237	18	34	.150	28	26	.150	32	20	.165
Chestnut oak	2	4	.019	8	8	.046	12	20	.092	6	. .	.019
Post oak	2	. .	.006	. .	. .	. . .	2	. .	.006	. .	. .	. . .
Other oaks	42	34	.237	30	24	.127	20	26	.133	16	26	.134
Beech	. .	4	.012	12	. .	.035	12	. .	.035	8	. .	.025
Maple	2	. .	.006	. .	. .	. . .	. .	. .	. . .	6	. .	.019
Chestnut	4	. .	.012	26	16	.121	14	. .	.040	12	10	.070
Hickory	10	4	.043	16	18	.098	18	30	.139	20	26	.140
Yellow poplar	9	8	.053	18	8	.075	8	8	.046	6	. .	.019
Gum	. .	6	.019	. .	6	.017	. .	. .	. . .	. .	. .	. . .
Ash	5	4	.028	6	6	.035	. .	. .	. . .	.	4	.013
Linden	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Sycamore	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Buckeye	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Elm	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Black walnut	12	8	.062	. .	. .	. . .	6	18	.069	20	10	.095
White walnut	4	6	.031	. .	. .	. . .	. .	. .	. . .	21	. .	.067
Hemlock	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .
Pine	. .	11	.034	. .	16	.046	2	24	.069	8	9	.054

TABLE II.—Second Growth—Continued.

SPECIES.	*Clinton Furnace Lands, Boyd C'ty.*			*N'r Grayson, Carter County.*			*Buffalo Furnace, near head of Old-town Cr'k, North Fork.*			Per cent. for all localities—side of hill	Per cent. for all localities—top of hill	Per cent. for all localities
	Hillside (horizon of L. ore and C. No. 7), 50 to 100	Top of hill (horizon of No. 8 C.), 150 to 200	Per cent. for locality	Hillside (horizon of No. 2 C.), 100 to 150	Top of hill (horizon of No. 3 C.), about 200	Per cent. for locality	Hillside (horizon of No. 2 C.), 100 to 150 above drainage	Divide (horizon of No. 3 Coal), 250 above drainage	Per cent. for locality			
White oak	32	36	.223	32	22	.160	30	33	.187	.191	.210	.202
Black oak	38	30	.223	32	34	.200	35	36	.211	.189	.191	.190
Chestnut oak	16	4	.066	14	16	.089	. .	. .	. . .	.050	.045	.048
Post oak	12	2	.046	6	6	.036	. .	9	.027	.019	.015	.017
Other oaks	40	16	.184	12	24	.107	10	12	.164	.138	.141	.140
Beech	6	4	.033	22	8	.089	15	. .	.045	.065	.014	.039
Maple	. .	2	.007	16	26	.025	11	. .	.033	.030	.024	.027
Chestnut	8	14	.072	. .	12	.036	16	30	.137	.069	.071	.070
Hickory	. .	6	.020	16	16	.095	13	12	.074	.080	.098	.089
Yellow poplar	12	. .	.039	. .	. .	. . .	9	12	.062	.054	.031	.042
Gum	4	3	.023	8	3	.032	5	9	.042	.015	.024	.019
Ash	. .	. .	. . .	. .	. .	. . .	2	9	.033	.011	.024	.016
Linden	. .	.	. . .	. .	. .	. . .	. .	6	.018	. . .	. . .	.003
Sycamore	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. . .	. . .	. . .
Buckeye	. .	. .	. .	. .	. .	. . .	. .	. .	. . .	. . .	. . .	. . .
Elm	. .	. .	. . .	12	. .	.036	. .	. .	. . .	.010	. . .	.005
Black walnut	12	4	.052	. .	. .	. . .	7	9	.048	.049	.043	.046
White walnut	. .	. .	. . .	. .	. .	. . .	. .	6	.018	.022	.010	.016
Hemlock	. .	. .	. . .	. .	. .	. . .	. .	. .	. . .	. . .	. . .	. . .
Pine	. .	4	.013	. .	. .	. . .	. .	. .	. .	.007	.056	.031

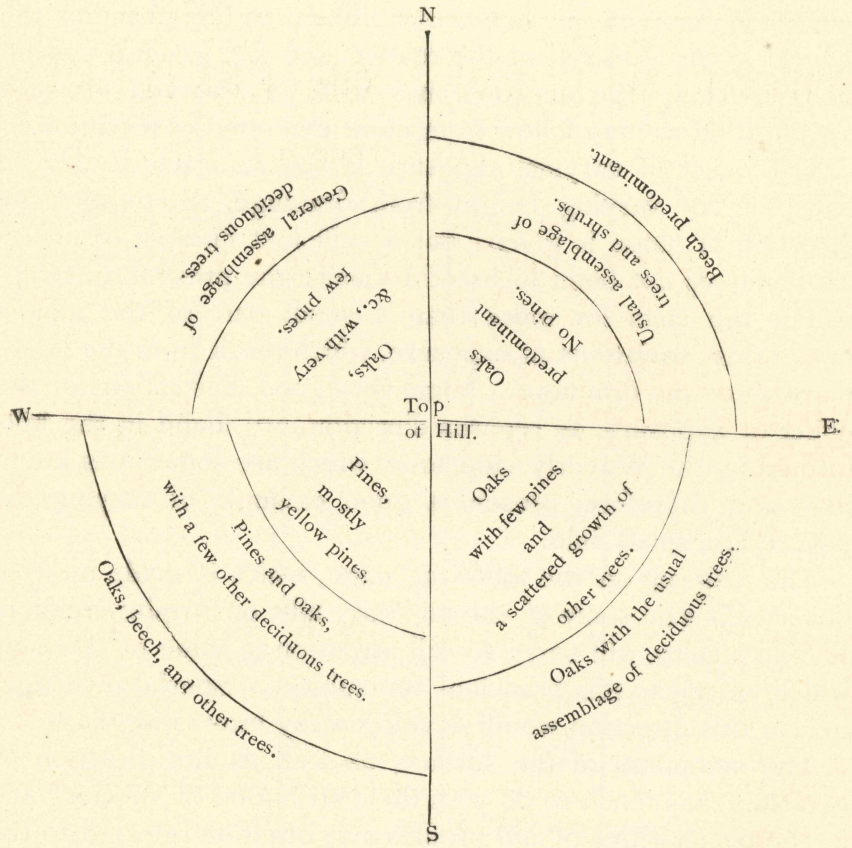
DISTRIBUTION OF SPECIES AS AFFECTED BY TOPOGRAPHICAL FEATURES.

In the first tabular view the effects of these conditions which arise from the hilly character of Eastern Kentucky may be traced in considerable detail. A careful study of this table will place many of the facts which belong to this phase of the subject at the disposal of the reader, and any general conclusions touching the question may well be reserved for such modification as may follow from more extended observation.

The effect of varying exposure is less satisfactorily shown than that of varying height from drainage. Generally the direction of slope is given; but a sufficient number of observations have not been included to make the presentation represent the facts for more than a small part of the almost numberless variations in exposure, which result from the irregularities of the drainage. Some very good illustrations of the effect of exposure, as regards direction, are found in the hills formed by the Waverly sandstone, which are sometimes knoblike, and, therefore, present a good example of varying exposure in a small field.

The diagram on the following page, which is made up from observations on some of the knoblike hills on Triplet creek, in Rowan county, will serve to call attention to some of the facts which belong to this branch of the subject. Special investigation in this direction would develop many interesting facts.

The steepness of the surface, as well as the direction of exposure, has much to do with the distribution of species; and as the peculiarities of hill profiles may often be referred to the character of the rocks out of which the hills are carved, as it were, by the agencies of erosion, the effects of varying exposure are more or less intimately associated and blended with those effects which properly belong to the question of geological distribution. A discussion of the relation of the two phases of the subject may, therefore, be left for a fuller presentation of the whole question.



GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT ON THE BOTANY

OF

BARREN AND EDMONSON COUNTIES,

BY JOHN HUSSEY, BOTANICAL ASSISTANT,

WITH AN INTRODUCTION BY N. S. SHALER.

INTRODUCTION.

The following report of Professor Hussey, Botanical Assistant of the Survey, is published in advance of the completion of the work of which it forms a part, in order that there may be some immediate record of the economic and scientific value of the forest trees and other plants of Western Kentucky. I am satisfied that the very great importance of the store of woods useful in the arts found in Western Kentucky has been greatly overlooked, and deserves immediate attention. The finest hard-wood forests known to me in any country lie between the Louisville and Nashville Railroad and the Mississippi river. I am confident that there is no other region on this continent where as large a mass of timber useful in the arts, and contiguous to transportation, can be found.

The arts into which these varieties of wood enter are multifarious, and of the greatest economic importance. I am satisfied that there is no point in America where so extensive opportunities exist for the creation of a direct trade in hard-wood with Europe. For many years wine-cask staves have been shipped from this district to New Orleans, and, though by the imperfect organization of the business half a dozen profits are paid before they come to the coopers' hands in France, they pay the best profits that are made on the oak timber in this district. By very little effort the casks could be made on the French models on the ground, and shipped as bundles of staves to Europe. A precisely similar industry exists in the shipment of sugar-boxes from the State of Maine to Cuba, the parts being bound up in "shooks" and bundles. By this arrangement the value of this industry to our people would be greatly increased. The demand from this source is very great, and steadily increasing. Another most promising industry has yet to be begun on this ground, though existing elsewhere in

less favorable portions of this country, viz: the making of carriage-parts hubs, felloes, and other elements in such structures, for export. For this purpose the new growth of timber on the barrens, as well as much of the slow growth oak, hickory, &c., of other parts of this district, is peculiarly fitted, having all the properties of second growth. All along the tributaries of Green river we have admirable trees for such industries; places where water-powers can be utilized at actual contact with permanent navigation for steamers directly connecting with New Orleans by the cheapest possible carriage.

The ample stores of oak and other ship timbers along this stream suggests the possibility of developing another industry here. Good ship timber can be had in this district at one third the lowest prices ruling on the Atlantic seaboard. Food is scarcely half as dear. So I am confident that a given tonnage would not cost one third what it would in transatlantic ports, as far as these elements of cost are concerned. Coal for running saw-mills, where steam-power is preferred, can be had for about two dollars and a half a ton. When built, ships would not want for cargo. They could be laden with timber or grain, and could be taken without risk to New Orleans each winter, though drawing as much as twenty feet of water. This is beyond all needs of vessels of this class. Used in this fashion, there is an immediate and most important source of wealth in our vanishing forests, which exceeds computation. Again and again, on the borders of Green river, I have seen, in a few dozen acres of tobacco clearings, enough noble ship timber going to utter waste by fire or decay to have built half a dozen large merchantmen. If such a demand could be created, there are tens of thousands of acres in every Green River county that would be worth a hundred dollars per acre for their timber alone.

In a certain way, the hard-wood timber of Western Kentucky is a more immediate and satisfactory source of wealth than its coal or iron. It takes less capital to develop an industry in it, and the competition will be far less considerable. At the same time, in the class of population it attracts to the State,

and the variety of industry it brings in its train, the industries in wood are superior to all other forms of manufacturing.

The scientific questions connected with our Western forests are even as interesting as those of an economical nature. While they must be reserved for special discussion in the memoirs of the Survey, where, as matters of purely scientific value, they will find their proper place, a brief statement of some of the most important points may be admitted here. In connection with the ancient barrens or prairies, which gave their name, in itself a misnomer, to Barren county, one of the most fertile regions in the State, we have two important questions: First, as to the origin of the treeless conditions which prevailed there when our race first came into the region; and secondly, how the retimbering was effected. The discussion of the first of these questions will lead us far into the difficult problems connected with the origin of prairies. I would only suggest, that inasmuch as the forests came back on the stoppage of the fires, to which reference is made in the following report of Professor Hussey, it is not unreasonable to look to for sweeping fires as the cause of the first destruction of the timber. We have seen within a few years how forest fires, once gaining headway in an unusually dried forest, may sweep over hundreds of miles of territory. A practice of firing prairies long continued might in time extend their limits from the regions where they are natural, from the absence of sufficient rainfall, over more and more of the forest area, until the prairie area had been driven from the Upper Missouri into the central regions of the Ohio Valley. This seems to me the most satisfactory method of accounting for the change.

The rapid restoration of the timber in Kentucky and parts of Indiana and Ohio, while the prairies of Illinois show but little tendency to restore their timber, is less easily to be explained. I am inclined, after considerable study of the matter, to conclude that the "barrens" or prairies of Kentucky had not been long stripped of their timbering, the period of open conditions having endured for such little time that the seeds of the trees had not all decayed in the soil. In no other way could the

exceedingly rapid return of the forests be explained. It has not yet been possible to adopt the statistical plan of studying our western forests shown in the report on the forests of Greenup county, &c. When this is done, it will be seen that the new or second-growth forests on the "barrens" is not nearly as diversified as the other and older forests; there being far more variety in the trees of the old than there is in the new forests.

Assistant John R. Proctor, of the Kentucky Survey, has made some important observations as to the Western forests of the old "barrens," going to show that the conglomerate or beds just below the coal form a natural limit to this once treeless area on the west. The detail of these observations will properly find a place in the proposed memoirs on the distribution of the forest trees of Kentucky.

N. S. SHALER.

INTRODUCTORY LETTER.

Professor N. S. SHALER—

SIR: The accompanying report is, as you will see, on the basis of actual collection. The number of plants in the list could have been greatly augmented had I placed in it plants observed, but not collected.

The first part is a list of the collections actually made, arranged according to the catalogue of Mr. A. H. Curtiss, which follows the order of Gray's Manual.

The second part is made up of Notes on Distribution, Territory Collected Over, and Botanical and Economical Notes. This part could have been greatly enlarged; but I thought that it would be better to await the results of a further prosecution of the Survey, to enlarge upon the peculiarities, the richness, and the economical value of the Flora of Kentucky.

Respectfully,

JOHN HUSSEY.

LAFAYETTE, IND., March 15, 1875.

REPORT ON THE BOTANY

OF

BARREN AND EDMONSON COUNTIES.

By JOHN HUSSEY.

TERRITORY COLLECTED OVER.

My collections were made in the western part of Barren county, or that part west of the Louisville and Nashville Railroad, in the Cave region, and in the county of Edmonson. My observations in Barren county would lead me to the conclusion that the traditions which are current as coming from the settlers are true; that is to say, that when the whites first came to these parts, it was, indeed, a barren region, destitute at least of trees. On the more level parts of this county the trees are yet small in size and few in species. The size of the trees alone would settle the question as to the length of time in which the present forest has stood, especially when taken in connection with the absence of the remnants of an older forest in the matter of fallen trunks and stumps. On the line of sandstone-capped hills seen rising between the line of the railroad and Green river are to be found larger trees than any in the more level portions of the county, showing that when the rest of the county was bare of trees, there were some crowning these hills. The limited number of species found in Barren county would itself be conclusive of the question of the recent introduction of forest growth into this region. The most of the oaks are of the following species: *Quercus, coccinea, rubra, nigra*—the latter species very numerous. *Alba* is found, but not abundant; also *imbricaria* and *obtusiloba*, about the numerous sinkholes. I saw no poplars, no tulip trees, linn, beech, black walnut, or butternut.

The largest trees are oaks, about fifteen inches in diameter three feet from the ground. I saw scarcely a willow or a maple of any kind. The soil is a stiff limestone, considerably impregnated with iron, making it of a red color, and not highly productive of ordinary cereals. The surface is very uneven, being full of sinkholes, formed by the falling in of the cavernous passages which form a network under this whole district. The celebrated Mammoth Cave is only one of the hundreds of caverns of this remarkable region. Not in the trees only, but also in the herbaceous flora, was the limited number of species noticeable. It is well understood that the aborigines of this country were accustomed to burn over the surface of the prairies; but for what purpose it does not seem to be perfectly understood. There may have been several considerations which led them to this quite universal custom. It has been said that they thus destroyed the old culms of grass, and cleared the way for the springing of the tender shoots in the spring. They may also have had in view the destruction of hurtful insects, as the grasshoppers, by destroying their eggs, or of noxious serpents, which must have been destroyed in immense numbers by the annual fires on the prairies. Another reason may have had consideration; the tall dead grass would be liable to be fired by accident at any time, and thus human life and many villages be endangered in the night, or in times of high winds, with no means of escape; but if at a certain time, when all are on the lookout, the firing should take place, there would be no danger to life or property.

This habit of firing the prairies must have exerted a wide influence on the character and distribution of plants in the parts of our country where prairies existed. Certain plants could not survive the fires. The annuals must have been greatly diminished by the custom. Those which were perennials under ground, would suffer less than any other class of plants. The fire swept off everything above the surface—seeds not covered by the soil, young plants of trees; but the well-protected living roots of herbaceous perennials, with the nourishment of another crop of shoots stored away safely be-

neath the sod, suffered no damage. But as these fires were annually kindled, how did it happen that here and there all over the broad prairies clusters of trees withstood their destructive influence, and lived and flourished? The reason of the deficiency of trees on the prairies has been held by some to be the absence of the nutriment in the soil which they required, or the fineness of the soil, which was supposed to be unfavorable to the growth of timber trees. This latter view, taken in connection with the fact that the knolls on which the clumps of trees are generally found are composed of more porous material, as sand or gravel, seemed to receive confirmation. But the fact that all kinds of trees do grow well when planted and protected in prairie soil, upsets both these theories without further refutation. The soil is not too finely divided; it does not lack the necessary constituents. Not taking into consideration how a country may have been deprived of a forest—whether by the ravages of insects, a succession of unfavorable seasons, or by a conflagration alone, or connected with one or all of the foregoing causes, or by any other cause—when once deprived of a forest, annual fires would likely prevent its restoration while they were continued. If the fires were purposely kindled, and at a certain time, so that the villages could be protected against their ravages, the inhabitants would do it by clearing away the dead grass from the vicinity of their dwellings. In fact the grass would perish to the roots around their villages from being trampled upon and burnt out by the fires in and about their habitations. It is not beyond supposition that the aborigines themselves, for various reasons, might scatter the seeds of trees intentionally or accidentally, from the mast with which they must have provided themselves for winter consumption. They would occupy the knolls, if such there were, for their villages. The aboriginal well knew where the beds of gravel were, as is proved by the use he invariably made of them as repositories of his dead. Throughout Western and Southern Ohio scarcely a terrace gravel-bed has been dug out and removed for road-making, but has been found to have been used as a place of interment for his dead.

I had no opportunity to learn by observation how extensive the prairie was, a part of which extended into that portion of Barren county in which I collected. It evidently extended some distance south or southeast of Bowling Green; but how far it did extend in this direction or eastward, I had no opportunity to observe. To the westward, in Edmonson county, there is evidence of the treeless condition existing. The very numerous ravines, valleys, and hillsides, become covered with tree growth first. The large tulip trees, hemlocks, sugar maples, beeches, and chestnuts found in these less exposed localities, prove that generations of tree growth have passed since their seeds were scattered here; but the uplands show, that long since the deep valleys and hillsides were covered with forest growth, these were almost or entirely bare. Notwithstanding this, however, Edmonson county was forest-covered a generation before Barren county.

Taking the two counties together in which my collecting was done, they differ very much in surface character. In Barren county the prevailing rock is limestone, except on the caps of the high hills, where sandstone is found. But in Edmonson county the heavy conglomerate and sandstone of the carboniferous period prevails at all points. The deep gulches cut by the numerous tributaries of Nolin and Bear creeks give a very different character to the geography of this county from that of Barren. These gulches must considerably modify the climate; at least in them and beneath their immense walls of conglomerate and sandstone the extremes of heat and cold are greatly modified, and protection is furnished to several species of plants not found out of these places in this region.

BOTANICAL NOTES.

The list accompanying this will show the limited number of species found in the counties collected over. To give a correct understanding of the list, I should state that my collecting was confined to the months of May, June, July, and a few of the first days of August. The weather was unusually dry, which I suppose exerted an unfavorable influence upon the number of

species. When it is borne in mind that this region is widely separated from the Allegheny Mountains, that it is not a high region, the presence of *Abies Canadensis* will be unexpected; but this makes a large growth in the gulches of Edmonson county. The *Ilex opaca* attains the size of fifteen to eighteen inches in diameter, and forty to fifty feet in height. The little shrubs, *Mitchella repens* and *Gaultheria procumbens* were found in abundance there. *Kalmia latifolia* is abundant. The *Ptelea trifoliata* grows on the Nolin. I mention this to say that I noticed that the petals did not open in all instances, but cohered at their apices, and were pushed off by the stamens and pistils as in some species of the vitis genus.

The *Spiraea aruncus* was a very common plant, and I noticed a feature of it which I have never seen referred to by any one; it was the occurrence of a small deciduous bractlet on each pedicel, but not touching the flower. The *Leavenworthia Michauxii* was collected by me near the town of Glasgow Junction, just northwest of town, growing in a nearly filled-up sinkhole. This is quite a rare plant, and but few specimens were found. *Trifolium reflexum* occurs in several localities between the railroad and Mammoth Cave, which is in the eastern part of Edmonson county. I mention it because I have never found so many specimens in any one locality before, and also to make a note of the fine rose-pink color it everywhere had. The variety of *Celtis occidentalis*, called *pumila*, commences to appear in Barren county, and extends everywhere through the country as far as Hopkinsville, in Christian county. I did not see the ripe fruit; but shrubs ten feet high were not uncommon, with an abundance of fruit. The leaves are thin, smoother than those of the large form, and much tapering. I did not see a large tree of *Celtis occidentalis* anywhere in this section such as are everywhere seen in creek bottoms north of the Ohio. Among ferns, I found, in Barren county, growing on the extreme eastern end of the sandstone ridge, under which is Short Cave, *Cheilanthes vestita*. The hairs on this fern were distinctly jointed, and between each joint much flattened; but the contiguous sections flattened in different planes. This character

is not given in descriptions, although in other species of the same genus the hairs are called "obscurely or distinctly articulated;" and in one the word "flattened" is added—*vide* Gray's Botany.

The fern *Polypodium incanum* was collected on that ledge of sandstone running between the mouth of Mammoth Cave and Green river, and perhaps two hundred yards from the main entrance to the Cave. It was also found growing on a large sand rock on the west fork of the creek, which flows by the old iron furnace west of Nolin, and about one half mile above the furnace. I did not find it in any other locality in the county. I consequently did not find it growing in the moss on trees or the roots of trees. Those places where I did gather it were very dry; had as little opportunity for moisture as any places I could name. One was on the edge of a sand rock among dried-up moss. With the other was found growing the *Camptosorus rhizophyllus*. Mr. W. T. Knott, of Lebanon, Kentucky, showed me a single frond *Polypodium incanum*, which he had gathered among moss on earth beside a stream. Mr. John Williamson, of Louisville, has found this fern within twelve miles of that city. I found the *Asplenium Bradleyi* on a cliff at the head of Dismal creek. It grew on the face of a steep sand rock exposed to all the vicissitudes of the weather. This limited locality was the only place of its occurrence, according to my observation. It seems here as a relic of a former period, having perished from all these miles of cliff formation, and lingering here awhile before giving up the struggle of existence so far to the north. A hundred or so fronds were all I had heart to gather, not willing to hasten its extermination by any act of mine.

The *Trichomanes radicans*, by a singular coincidence, was found growing near, on, or rather under, the same cliff. This rare fern I found in about a dozen localities in this county, always growing on the under side of an overhanging sand rock, where the moisture trickled down and kept the leaves bedewed with spray. I collected this fern also last year in the extreme eastern part of this State, in Carter county. The fronds evi-

dently remain active for several years. They bear their spore cases on the end of veins on the edges of the fronds. In no case have I ever seen a frond, which seemed recently unfolded, develop its spore vessels. A season of repose, of longer or shorter duration, occurs after its development, before it puts forth its little cups, from the bottom of which the bristle grows, and at the base of which the *sporangia* develop and cluster. But what seemed still more curious to me is the fact that the crops of *sporangia* are not all formed and ripened at once; but they are successively developed at the base of the lengthening bristle. I have seen these bristles more than half an inch long, and still beset at the base with ripening *sporangia*, the scars left by those long since fallen being still visible all along the bristle. I think the life of a fertile frond may be for as long as four or five years. It may not be out of place to add, that the fronds were generally well filled with spore vessels. It is probably due to the fact that the numerous flocks of sheep which find protection under the overhanging cliffs during winter, and feed upon this fern, that its extinction seems so near at hand. There were hundreds of situations where it might flourish as well as where it was found, but where it is not found to grow; and those places where it was found were inaccessible to the sheep, either by being above their reach or too far under the rock. I had often to crawl or draw myself in to where it covered the under surface of the overhanging rock, where there was barely room for my head and shoulders.

ECONOMICAL NOTES.

Turning to the more practical side of my work, I can say that the quantity of valuable timber-trees seems practically inexhaustible.

Soft-wood.—The tulip tree, in the west commonly called poplar (*Liriodendron tulipifera*), is abundant along the tributaries of Green river. The trees are of large size, and make good lumber. Those which grew nearest the river and its principal tributaries have been mostly floated down the river; but in the country back there is still much of this valuable timber.

The *sweet gum* (*Liquidambar styraciflua*) is still very abundant on the river and its tributaries. This tree has not been sought after so much as the tulip tree, and, consequently, has not been removed to so great an extent. It is a soft wood, and valuable for most purposes where poplar has been used. For all kinds of structures, where there is no immediate exposure to the weather, this is a valuable wood. The trees are of immense size, being frequently found in the counties lying next down the river from Edmonson county, four and a half feet in diameter and seventy to eighty feet high, with scarcely a limb. They equal the largest poplars. There is not much *linn* or bass-wood (*Tilia Americana*) found on the tributaries of Green river. The trees found are small and of little value for sawing.

Hard-wood.—The species of oak, known among wood-workers as white oak, attains an enormous development along Green river. The white oak, burr oak, and swamp white oak, form immense trunks, reaching to a height of eighty feet, where they still seem to be three feet in diameter. One could hardly determine which to admire most—their number, their size, or grand uniform straight trunks. Although for thirty years the trade in French butts via New Orleans has existed, one cannot see that even an impression has been made on the supply. Timber which has stood the test for such a long period of time in the manufacture of wine-casks needs no recommendation from any one.

The *Spanish oak* is very plentiful in some localities. The timber of this species of oak is valued for wagon-work of all kinds, and is scarcely, if at all, inferior for such manufactures to white oak. The bark is also used in tanning.

Chestnut oak is abundant on the ridges on both sides of Green river, but especially to the west of it. The largest *beech trees* I have ever seen are very abundant on Green river. Their trunks are finely formed, running up forty to fifty feet without any large branches, and as much as three feet in diameter three feet from the ground.

The *chestnut* is abundant also.

The *hickories* are among the largest trees—very tall, but not so great in diameter as the oaks and sweet gum, but exceedingly numerous. Neither *black* nor *white walnuts* are here found in abundance, and the trees which are found are of inferior size. The *wild cherry* is not abundant. The *sugar maple*, *black birch*, and *hemlock* are common in the gulches. The white soft maple is found everywhere. On the uplands hoop-poles seem quite inexhaustible in quantity, and of very good quality.

Black hickory (*Carya Tomentosa*), when from five to ten inches in diameter near the base, is used for making bent-work in the manufacture of buggies and carriages, and for other uses. In the counties of Grayson and Edmonson there is an immense supply of this class of wood. Much of it is too far from the railroad to bear hauling by wagon, and then car transportation to points where it is manufactured into carriage stuff. If some company would put up machinery in the midst of the material, it would certainly prove remunerative if properly carried on. The timber would cost but a trifle, labor in abundance could be had at a fair price, and fuel would be very low, as in many places coal is to be had for the digging from hillside veins. The manufactured articles could be got away at a small expense compared with that of hauling the rough timber. During the winter and spring months, when the river and its tributaries are in good stage of water, the expense of getting material transported would be comparatively little. The large quantity of the right kind of material found here, the extreme abundance of fuel and cheap labor, would give a well-managed company the control of the market in such manufactures.

White elm, so-called in this State (*Ulmus alata*), is very abundant all through the counties of Grayson and Edmonson, as well as in the other parts of the State, especially along the tributaries of Green river below these counties. This is one of the valuable materials for manufactures found here. The wood fibres of the elm interlace, and render the wood tough and difficult to split, while it is both light and elastic. These are the qualities desired in hubs for carriages, small spring-

wagons, and buggies. No iron bands are required, and they may be very light; at the same time they are strong, and neither split or crack if properly seasoned. A large quantity of this wood is found of the right size for the uses named.

Mulberry, *sassafras*, *chestnut*.—The value of the trees just named for fence-posts is not well understood. Mulberry is equal to black locust in all respects, except that it does not become quite so hard. The sassafras is scarcely, if at all, inferior to either, and both are found here in considerable quantities. The sassafras is a tree of rapid growth, and springs up everywhere in old fields and abandoned ground. The wood is light, but tough enough to hold nails, and is very enduring in all exposures. The chestnut is valuable wood for posts, but it should be cut at the season when there is the least sap in the wood to prevent the ravages of insects, and that decay produced by decomposition of the sap. The month of August or September, when the growth of the season is completed, and there is usually a deficiency of moisture in the ground, would be the best time to cut it. By dipping the end of the seasoned wood which is to go into the ground in hot coal-tar, a post will be secured which will outlast a generation. The time is coming when either fencing must be abandoned, or some other material than oak on the one hand, which is too perishable, or locust or cedar on the other, which will be too expensive, must be found. With seasoned posts of either of these trees, and seasoned chestnut boards, a fence will be made which will last a generation.

Turning-wood.—The elm (*Ulmus alata*), which is a fine-grained white-wood, the dogwood (*Cornus Florida*), buckeye (*Aesculus* of several species), the holly (*Ilex opaca*), the hop-hornbeam (*Ostrya Virginica*), and the ironwood (*Carpinus Americana*)—these and other trees, suitable for the manufacture of turned work of various kinds, exist in great abundance. The dogwood is specially abundant, and of large size for that little tree, sometimes eight or nine inches in diameter, and is of well-known properties; the wood is very hard and compact when seasoned, and useful for any kind of turned work requir-

ing fineness of grain and hardness. For work requiring soft white-wood, the elm, holly, buckeye, with many others, such as white soft maple and linn, give a wide range for choice, and all are to be had in considerable quantities.

FRUIT-RAISING.

This branch of industry has been neglected hitherto in the part of the State under consideration. But many localities offer good inducements to persons fitted for, and inclined to, this agreeable and often profitable pursuit. That series of hills known as Muldraugh's Hill, connecting east with the spurs of the Cumberland Mountains, and with more or less altitude extending westward to the Ohio river, are becoming known to be well adapted to the growth of various kinds of fruits, among which are the peach and strawberry. The series of hills in the western part of Barren county, running nearly parallel with Green river, it is also known, are equally adapted to the peach, which seldom fails to produce good crops. The same is true of localities in Edmonson county, near the course of the Nolin, where peach trees are said never to have failed in any season, for forty years, to bear. The distance from good markets is the great hindrance to the extension of this industry. With the use of the new and improved methods of desiccating fruits, perhaps it would be equally profitable to take them to market in a dried condition, especially when we consider the low price of land in settlements remote from railroads and large towns, and the comparative cheapness of labor.

CONCLUSION.

When a full survey of the resources of the State of Kentucky shall have been made, it will be found that the wealth of her forests and the natural productions of her soil will be a matter not insignificant, even when compared with the inexhaustible resources of coal and iron beneath the surface. From the extreme east to the west of this great State every part is clothed with the most valuable kinds of wood, from the bald cypress of the extreme southwest to the white pine in the

Cumberland table-land, and to the inexhaustible oak forests of the Green river counties, and those of the eastern and southeastern part of the State. This timber is not to be regarded as treasured-up wealth—to be preserved and held sacred, and its removal to be deplored—but rather as wealth wasting, as capital lying idle and unproductive. Trees have their period of life—their time of death. Go through the broad forests and see how the giants of vegetation are falling into decay; creaking and dismantled by the storms, or mouldering away prone upon the earth. When any tree is full grown, it should be removed and give place to others striving to exist under its shade. A wise use of the woodman's axe is not to be deplored—it may be a saving as well as a wasting agent.

Ranunculaceæ—

Clematis Viorna, L.
Clematis Virginiana, L.
Anemone Caroliniana, Walt.
Hepatica triloba, Chaix.
Hepatica acutiloba, DeC.
Thalictrum anemonoides, Michx.
Thalictrum dioicum, L.
Thalictrum purpurascens, L.
Thalictrum clavatum, DeC.
Ranunculus recurvatus, Poir.
Ranunculus repens, L.
Isopyrum biternatum, T. and Cr.
Aquilegia Canadensis, L.
Hydrastis Canadensis, L.
Actæa spicata, L., v. rubra, Mx.

Magnoliaceæ—

Magnolia acuminata, L.
Magnolia umbrella, Lam.
Liriodendron tulipifera, L.

Anonaceæ—

Asimina triloba, Dunal.

Menispermaceæ—

Menispermum Canadense, L.

Berberidaceæ—
Jeffersonia diphylla, Pers.
Podophyllum peltatum, L.
Nymphæaceæ—
Nelumbium luteum, Willd.
Papaveraceæ—
Sanguinaria Canadensis, L.
Fumariaceæ—
Corydalis glauca, Pursh.
Corydalis aurea, Willd.
Cruciferæ—
Leavenworthia Michauxii, Torr.
Dentaria laciniata, Muhl.
Cardamine rhomboidea, DeC.
Cardamine hirsuta, L.
Violaceæ—
Viola sagittata, Ait.
Viola pedata, L.
Viola pubescens, Ait.
Cistaceæ—
Lechea minor, Lam.
Hypericaceæ—
Ascyrum Crux-Andreæ, L.
Hypericum prolificum, L.
" " v. densiflorum.
Hypericum corymbosum, Muhl.
Hypericum mutilum, L.
Caryophyllaceæ—
Silene stellata, Ait.
Silene Pennsylvanica, Mx.
Silene Virginica, L.
Silene antirrhina, L.
Arenaria serpyllifolia, L.
Arenaria patula, Mx.
Stellaria pubera, Mx.
Cerastium nutans, Raf.
Sagina nodosa, Fenzl.

Anychia dichotoma, Mx.
Mollugo verticillata, L.
Portulacaceæ—
Portulaca oleracea, L.
Claytonia Virginica. L.
Tiliaceæ—
Tilia Americana, L.
Linaceæ—
Linum Virginianum, L.
Geraniaceæ—
Geranium Carolinianum, L.
Geranium Robertianum, L.
Rutaceæ—
Zanthoxylum Americanum, Mill.
Ptelea trifoliata, L.
Simarubaceæ—
Ailanthus glandulosus, Desf.
Anacardiaceæ—
Rhus glabra, L.
Rhus copallina, L.
Rhus venenata, DeC.
Rhus Toxicodendron, L.
" " v. radicans (L.), Torr.
Rhus aromatica, Ait.
Vitaceæ—
Vitis æstivalis, Mx.
Vitis cordifolia, Mx.
Vitis vulpina, L.
Vitis indivisa, Willd.
Ampelopsis quinquefolia, Mx.
Rhamnaceæ—
Ceanothus Americanus, L.
Celastraceæ—
Celastrus scandens, L.
Euonymus atropurpureus, Jacq.
Euonymus Americanus, L.

Sapindaceæ—

Æsculus glabra, Willd.
Æsculus flava, Ait.
Acer saccharinum, Wang.
" v. nigrum (Mx.), Gray.
Acer dasycarpum, Ehrh.
Acer rubrum, L.
Negundo aceroides, Mœnch.

Polygalaceæ—

Polygala ambigua, Nutt.

Leguminosæ—

Trifolium reflexum, L.
Medicago lupulina, L.
Psoralea melilotoides, Mx.
Robinia Pseudacacia, L.
Wistaria frutescens, DeC.
Tephrosia Virginiana, Pers.
Desmodium nudiflorum, DeC.
Desmodium pauciflorum, DeC.
Desmodium rotundifolium, DeC.
Lespedeza repens, T. & G.
Stylosanthes elatior, Swartz.
Vicia Caroliniana, Walt.
Phaseolus helvolus, L.
Clitoria Mariana, L.
Cercis Canadensis, L.
Cassia Marilandica, L.
Cassia chamæcrista, L.
Cassia nictitans, L.
Gymnocladus Canadensis, Lam.
Gleditschia triacanthos, L.

Rosaceæ—

Prunus Americana, Marsh.
Prunus cerasus, L.
Prunus serotina, Ehrh.
Spiræa corymbosa, Raff.
Spiræa Aruncus, L.

Gillenia stipulacea, Nutt.
Agrimonia Eupatoria, L.
Geum album, Gmelin.
Geum vernum, T. & G.
Potentilla Norvegica, L.
Fragomaria Virginiana, Ehrh.
Rubus villosus, Ait.
" v. humifusus.
Rubus Canadensis, L.
Rosa setigera, Mx.
Cratægus Oxyacantha, L.
Cratægus coccinea, L.
Cratægus crus-galli, L.
Pyrus coronaria, L.
Amelanchier Canadensis, T. & G.

Saxifragaceæ—

Hydrangea arborescens, L.
Saxifraga Virginiensis, Mx.
Heuchera villosa, Mx.
Heuchera Americana, L.
Mitella diphylla, L.

Crassulaceæ—

Sedum pulchellum, Mx.
Sedum ternatum, Mx.

Hamamelaceæ—

Hamamelis Virginica, L.
Liquidambar Styraciflua, L.

Onagraceæ—

Circæa lutetiana, L.
Gaura filipes, Spach.
Oenothera biennis, L.
Oenothera fruticosa, L.
Luwigia alternifolia, L.
Luwigia palustris, Ell.

Melastromaceæ—

Rhexia Virginica, L.

Lythraceæ—
Cuphea viscosissima, Jacq.
Passifloraceæ—
Passiflora lutea, L.
Umbelliferæ—
Sanicula Canadensis, L.
Daucus carota, L.
Thaspium aureum, Nutt.
Zizia integerrima, DeC.
Erigenia bulbosa, Nutt.
Araliaceæ—
Aralia racemosa, L.
Aralia quinquefolia, G.
Cornaceæ—
Cornus florida, L.
Cornus sericea, L.
Nyssa multiflora, Wang.
Caprifoliaceæ—
Sambucus Canadensis, L.
Viburnum prunifolium, L.
Viburnum nudum, L.
Viburnum acerifolium, L.
Rubiaceæ—
Galium Aparine, L.
Galium concinnum, T. and G.
Galium trifidum, L.
Galium triflorum, Mx.
Galium pilosum, Ait.
Cephalanthus occidentalis, L.
Mitchella repens, L.
Houstonia purpurea, L.
" v. longifolia, (Willd.)
" v. ciliolata, (Torr.)
Houstonia augustifolia, Mx.
Houstonia cærulea, L.
Compositæ—
Elephantopus Carolinianus, Willd.

Eupatorium perfoliatum, L.
Conoclinum cœlestinum, DeC.
Sericocarpus solidagineus, Nees.
Erigeron bellidifolium, Muhl.
Erigeron Philadelphicum, L.
Erigeron annuum, Pers.
Inula helenium, L.
Polymnia Canadensis, L.
Polymnia Uvedalia, L.
Silphium trifoliatum, L.
Parthenium integrifolium, L.
Rudbeckia hirta, L.
Coreopsis auriculata, L.
Coreopsis senifolia, Mx.
Maruta cotula, DeC.
Achillea millefolium, L.
Gnaphalium decurrens, Ives.
Gnaphalium polycephalum, Mx.
Gnaphalium uliginosum, L.
Senecio aureus, L.
Centaurea Americana, Nutt.
Cirsium Virginianum, Mx.
Cynthia Virginica, Don.
Hieracium Gronovii, L.
Taraxacum Dens-leonis, Desf.
Lactuca Canadensis, L.
Lobeliaaceæ—
Lobelia cardinalis, L.
Lobelia syphilitica, L.
Lobelia puberula, Mx.
Lobelia inflata, L.
Campanulaceæ—
Campanula Americana, L.
Specularia perfoliata, A. DeC.
Ericaceæ—
Vaccinium stamineum, L.
Vaccinium arboreum, Marshall.

Epigea repens, L.
Gaultheria procumbens, L.
Oxydendrum arboreum, DeC.
Kalmia latifolia, L.
Rhododendron maximum, L.

Aquifoliaceæ—
Ilex opaca, Ait.
Ilex mollis, Gray.

Ebenaceæ—
Diospyros virginiana, L.

Plantaginaceæ—
Plantago lanceolata, L.
Plantago virginica, L.
Plantago heterophylla, Nutt.

Primulaceæ—
Dodecatheon Meadia, L.
Lysimachia quadrifolia, L.
Lysimachia ciliata, L.
Lysimachia lanceolata, Walt.
Anagallis arvensis, L.
Samolus valerandi, L., v. americanus, G.

Bignoniaceæ—
Tecoma radicans, Juss.
Catalpa bignonioides, Walt.

Orobanchaceæ—
Epiphegus virginiana, Bart.
Conopholis americana, Wallr.

Scrophulariaceæ—
Verbascum Blattaria, L.
Scrophularia nodosa, L.
Collinsia verna, Nutt.
Chelone glabra, L.
Pentstemon pubescens, Soland.
Pentstemon digitalis, Nutt.
Mimulus alatus, Ait.
Conobea multifida, Benth.
Veronica serpyllifolia, L.

Veronica peregrina, L.
Seymeria macrophylla, Nutt.
Gerardia flava, L.
Castilleia coccinea, Spreng.
Pedicularis canadensis, L.

Acanthaceæ—
Ruellia strepens, L.

Verbenaceæ—
Verbena angustifolia, Mx.
Verbena bracteosa, Mx.
Lippia lanceolata, Mx.
Phryma leptostachya, L.

Labiatæ—
Trichostema dichotomum, L.
Pycnanthemum Tullia, Benth.
Pycnanthemum lanceolatum, Pursh.
Pycnanthemum linifolium, Pursh.
Salvia lyrata, L.
Salvia urticifolia, L.
Monarda fistulosa, L.
Blephilia ciliata, Rof.
Nepeta Glechoma, Benth.
Brunella vulgaris, L,
Scutellaria canescens, Nutt.
Scutellaria pilosa, Mx.
Scutellaria parvula, Mx.
Scutellaria galericulata, L.

Boraginaceæ—
Echium vulgare, L.
Lithospermum hirtum, Lehm.
Mertensia virginica, DeC.
Myosotis verna, Nutt.
Cynoglossum virginicum, L.
Cynoglossum Morisoni, DeC.
Hiliotropium europœum, L.

Hydrophyllaceæ—
Hydrophyllum macrophyllum, Nutt.
Hydrophyllum appendiculatum, Mx.

Polemoniaceæ—
Polemonium reptans, L.
Phlox glaberrima, L.
Phlox pilosa, L.
Phlox procumbens, Lehm.
Phlox divaricata, L.

Convolvulaceæ—
Quamoclit coccinea, Mœnch.
Ipomea pandurata, Meyer.
Convolvulus arvensis, L.

Solanaceæ—
Solanum carolinense, L.

Gentianaceæ—
Sabbatia angularis, Pursh.
Frazera carolinensis, Walt.

Apocynaceæ—
Apocynum cannabinum, L.

Asclepiadaceæ—
Asclepias phytolaccoides, Pursh.
Asclepias variegata, L.
Asclepias quadrifolia, Jacq.
Asclepias tuberosa, L.

Oleaceæ—
Fraxinus americana, L.
Fraxinus pubescens, Lam.
Fraxinus viridis, Mx.
Fraxinus quadrangulata, Mx.

Aristolochiaceæ—
Asarum canadense, L.

Phytolaccaceæ—
Phytolacca decandra, L.

Chenopodiaceæ—
Chenopodium urbicum, L.

Polygonaceæ—
Polygonum hydropiper, L.
Polygonum aviculare, L.
Rumex crispus, L.
Rumex acetosella, L.

Lauraceæ—
Sassafras officinale, Neeo.
Lindera Benzoin, Meisner.

Loranthaceæ—
Phorodendron flavescens, Nutt.

Saururaceæ—
Saururus cernuus, L.

Euphorbiaceæ—
Euphorbia maculata, L.
Euphorbia hypericifolia, L.
Euphorbia corollata, L.
Phyllanthus carolinenis, Walt.

Urticaceæ—
Ulmus fulva, Micheli.
Ulmus americana, L. Walld.
Ulmus alata, Michx.
Celtis occidentalis, L.
" " v. pumila, Pursh.
Morus rubra, L.

Platanaceæ—
Platanus occidentalis, L.

Juglandaceæ—
Juglans cinerea, L.
Juglans nigra, L.
Carya alba, Nutt.
Carya tormentosa, Nutt.
Carya porcina, Nutt.

Cupuliferæ—
Quercus alba, L.
Quercus macrocarpa, Mx.
Quercus Prinus, L.
" " v. monticola, Mx.

Quercus imbricaria, Mx.
Quercus nigra, L.
Quercus falcata, Mx.
Quercus coccinea, Wang.
Quercus rubra, L.
Castanea vesca, L.
Fagus ferruginea, Ait.
Corylus americana, Walt.
Ostrya virginica, Willd.
Carpinus americana, Mx.

Betulaceæ—
Betula nigra, L.
Alnus serrulata.

Salicaceæ—
Populus tremuloides, Mx.
Populus grandidenta, Mx.
Populus monilifera, Ait.
Populus balsamifera, L.

Coniferæ—
Pinus pungens, Mx.
Pinus inops, Ait.
Abies canadensis.
Juniperus virginiana, L.
Taxus baccata, v. canadensis (Willd.), Gray.

Araceæ—
Arisæma triphyllum, Torr.

Hydrocharidaceæ—
Vallisneria spiralis, L.

Orchidaceæ—
Liparis liliifolia, Richard.
Cypripedium pubescens, Willd.
Cypripedium spectabile, Swartz.

Amaryllidaceæ—
Hypoxis erecta, L,

Iridaceæ—
Iris cristata, Ait.
Sisyrinchium bermudiana, L.

Dioscoraceæ—
Dioscorea villosa, L.

Smilaceæ—
Smilax glauca, Walt.
Smilax tamnoides, L.

Liliaceæ—
Chamælirium luteum, Gray.
Uvularia perfoliata, L.
Allium canadense, Kalm

Juncaceæ—
Luzula campestris, DeC.

Commelynaceæ—
Tradescantia virginica, L.
Tradescantia pilosa, Lehm.

Filices—
Polypodium vulgare, L.
Polypodium incanum, Swartz.
Adiantum pedatum, L.
Pteris aquilina, L.
Cheilanthes vestita, Swartz.
Pellaea atropurpurea, Link.
Asplenium pinnatifidum, Nutt.
Asplenium Trichomanes, L.
Asplenium ebeneum, Aiton.
Asplenium montanum, Willd.
Asplenium angustifolium, Mx.
Asplenium thelypteroides, Mx.
Asplenium felix-foemina, Bernh.
Camptosorus rhyzophyllus, Link.
Phegopteris hexagonoptera, Fee.
Aspidium thelypteris, Swartz.
Aspidium noveboracense, Swartz.
Aspidium spinulosum, Swartz v. intermedium, Muhl.
Aspidium Goldianum, Hook.
Aspidium marginale, Swartz.
Aspidium acrostichoides, Swartz.
Cystopteris bulbifera, Bernh.

Cystopteris fragilis, Bernh.
Onoclea sensibilis, L.
Woodsia obtusa, Torr.
Dicksonia punctilobula, Kunze.
Osmunda regalis, L.
Osmunda Claytoniana, L.
Osmunda cinamomea, L.
Botrychium virginicum, Swartz.
Ophioglossum vulgatum, L.

Lycopodiaceæ—

Lycopodium selago, L.
Selaginella apus, Spring.

GEOLOGICAL SURVEY OF KENTUCKY

N. S. SHALER, DIRECTOR.

REPORT ON THE TIMBERS

OF

GRAYSON, BRECKINRIDGE, OHIO, AND HANCOCK COUNTIES,

BY L. H. DEFRIESE.

INTRODUCTORY LETTER.

Professor N. S. SHALER, *Director Kentucky Geological Survey*:

DEAR SIR: In 1874 the Geological Survey commenced a study of Kentucky timbers with special reference to the economic features of the State. In pursuance of the plan inaugurated then, and followed out by Messrs. Crandall and Hussey in their outcoming reports on the timbers of Greenup, Carter, Boyd, Lawrence, Barren, and Edmonson counties, I now submit a report on the timbers of Grayson, Breckinridge, Ohio, and Hancock counties.

The report is based upon a careful study made in those counties during May and June, 1876, and will be found, I think, tolerably thorough and accurate.

Very respectfully,

L. H. DEFRIESE.

REPORT ON THE TIMBERS OF GRAYSON, BRECKINRIDGE, OHIO, AND HANCOCK COUNTIES.

In the following report it will be noticed that I have confined my attention mostly to the trees, descending occasionally to the shrubs. The reason is obvious. In a report, whose object is mainly to give what is of economic value to the State, the timbers must occupy the chief place. While it would have been a pleasure to me to embrace in my study endogenous botany, especially the cryptogamia, every moment devoted to them would have been that much taken from the too short time that I had to devote to the timbers themselves.

The method of study pursued has been as follows: starting out from Leitchfield I followed the Leitchfield and Cloverport road northwest to the Ohio river, at Cloverport; thence down the Ohio to Hawesville; then southwest, across Hancock county, and back southeast, across Ohio county, to the Paducah Railroad, at Rosine Station. In this way I obtained two sections of timber, from Leitchfield north to the Ohio river, far enough apart to give any marked changes in the timber. Along the road, in both cases, I selected stations varying from four to eight miles apart, according to the local changes in timbers, and took a plot of representative ground, usually 50 or 100 yards square, on which I took the number of trees of different kinds. I carefully separated the old timber from the younger growth in all cases, in order to see how the future forest of Kentucky would compare with the present one in the relative per cents. of different kinds of timber. I also noted the position of the plot chosen for such enumeration—whether level, hillside, or hilltop; whether the exposure, if on a hillside, was north or south; the geological formation, the relative size, height, etc., of the

different kinds of trees. Mr. Crandall originated the idea, in 1874, of studying hill timber with reference to the points of the compass, in order to see the difference in timber produced by a northern, southern, eastern, or western exposure. In order to do that a rounded hill is selected, and at its base four plots of ground are chosen, on the north, south, east, and west sides respectively, and the per centage of different timbers carefully noted; then four other plots, half way up the hill, are chosen and counted in the same way; and finally the timber of the hilltop is carefully noted. Observations of this kind, extending over a considerable area, give sufficient data to show the effects upon the timber, both of the height above drainage and of direction of exposure. On page 16 of this report is a diagram giving the result of such observations made by me in Western Kentucky. I have also tried to connect any marked changes in the timber with the geological changes that caused them. Of course this is not always possible, for the conditions of timber growth are confined largely to the surface of the ground. It is, therefore, possible that a local change of the surface stratum will produce a change in the per centage of different timbers without the geological change being sufficient to notice. It is a question whether, if the flora of a country were closely studied with reference to its condition of growth, it would not form a nicer index to the surface changes of soils than the geologist now possesses. Up to this time, however, botany and geology have not been sufficiently connected to render them mutual aids in difficult cases.

While speaking of the connection between geology and botany, I wish to call attention to a rather marked example of it in Grayson county. The coal-measure series crosses the Leitchfield and Hartford road, in a very irregular northwest and southeast direction, about 12 miles from Leitchfield. The line of juncture between it and the Sub-carboniferous can be easily traced towards the Paducah Railroad. After crossing this juncture, on through the coal measures north to the Ohio, the liriodendron tulipfera (tulip tree, erroneously called yellow

poplar all through the country), forms a conspicuous part of the forest. Its massive, cylindrical trunk, from two to five feet in diameter, is seen everywhere, on lowland and highland alike. But after crossing over into the Chester shale, near Leitchfield, scarcely a liriodendron is to be seen. So marked and conspicuous is its absence that the eye can trace the giving out of the Chester shale toward the coal measures by that alone. A very few scrubby liriodendrons are found in choice locations (heads of branches, streams, etc.) near the juncture on the Chester shale side; but these soon give out, and within three or four miles of the juncture not one is to be seen. This marked disappearance in that region is doubtless due to surface changes caused by the change of formation, the coal measures supplying more of that loose, sandy, moist surface so suitable to the liriodendron. This absence of the liriodendron is confined to the Chester shale, however, and does not extend through the whole of the Sub-carboniferous; for further on, in the "sinking region," the surface exposure is the St. Louis limestone, on which the tulip tree grows in great numbers, and to great size.

Another instance of change in timber, due to a modification of the surface soil, is found in a remarkable belt of woods crossing the Hartford and Cloverport road about twelve miles from Cloverport. The belt is about five miles wide, on a soil of thin, shaly sandstone, which forms a nearly level tract of land. Although the ground is at least one hundred and fifty feet above the drainage of the country, the loose sandy soil is always moist. The consequence is a forest of liriodendron, chestnut, white oak, and three varieties of hickory, whose noble size and height I have not seen surpassed in Kentucky. In addition to these, but in less numbers, are also found laurel oak, black sugar maple, water beech, white elm, etc. The change is very marked on passing from this wood-belt into the ordinary timbers that bound it on each side.

In addition to the methods of choosing plots and numbering trees, mentioned before, between these plots I walked along, noting down every variety of tree that occurred, so as to

correct any error that might be made in choosing a piece of ground which did not fully represent the timber of the immediate locality. I then walked off the road on each side, making my observations extend over a belt about five miles wide, so as to still farther insure a correct representation of the timber.

The chief timbers of value in that part of Western Kentucky studied by me are: black walnut (*Juglans nigra*), white walnut (*J. cinerea*), white hickory (*Carya microcarpa*), shagbark hickory (*C. alta*), white oak (*Quercus alba*), swamp white oak (*Q. bicolor*), post oak (*Q. obtusiloba*), chestnut oak (*Q. castanea*), mountain chestnut oak (*Q. montica*), swamp chestnut oak (*Q. prinus*), tulip tree (*Liriodendron tulipfera*), hop hornbeam (ironwood [*Ostrya virginica*]), white ash (*Fraxinus americana*), blue ash (*F. quadrangulata*), black ash (*F. sambucifolia*), black cherry (*Cerasus serotina*), sugar maple (*Acer saccharinum*), black sugar maple (*Acer nigrum*), black birch (*Betula lenta*), beech (both *B. sylvatica* and *B. ferruginea*), and chestnut (*Castanea vesca*). Of these the black walnut is of course the most valuable. It is found scattered all through Western Kentucky, in open places and about fields, where other timbers have been cut away or deadened. It is nearly all second growth, however, the old forest growth having been ruthlessly destroyed. The largest amount of primal walnut timber I found was on Beech Fork of Clover Creek, up near the head waters. Occasionally a forest tree of it is left standing in other localities, but it is very rare. Even the second growth, which would be very valuable in time, is meeting with the same fate as the first; and reckless hands are cutting it away for such rude purposes as rail-making as fast as it springs up. From the study I made of the walnut, I find the second growth comes up only in open spots of ground, where it is not overshadowed and choked out by other more rapidly growing and less valuable timbers. That causes it to spring up mostly about dwelling-houses and cleared pieces of ground—the very localities where it soonest meets with destruction. If farmers could only consider that a single tree of good walnut timber is worth more

than their best acre of land, they would take more pains to encourage the growth of a timber which is becoming so scarce in our country, and for which there is such great demand. I believe, with a little extra care, such as trimming out and killing other fast-growing timbers of little or no value, taking moderate pains to secure, in such localities as best suited the walnut, a good undergrowth of it, etc., that a considerable forest of this valuable timber might be secured and kept in Kentucky.

Next to the walnut in value, and fully as scarce, is the black cherry. The wood is so valuable in cabinet work, for the reason that it is very compact, close-grained, and receives a high polish. In a few years, at the present rate of destruction, it will have disappeared from our Kentucky forests.

The great forest timber of Western Kentucky is the white oak, which probably forms forty or fifty per cent. of the entire forest trees, or nearly as much as all other species together. Its timber is so valuable in the making of wagons, agricultural implements, and all other articles where a tough, durable, nicely-grained wood is required, and one which warps but little in seasoning, that no special mention of its claims is necessary. But the very abundance of white oak in the Kentucky forests to-day obscures the extermination to which it is liable, and which is fast approaching. I took particular pains to notice the conditions of growth of the white oak, and I find that, while at present it forms the large per cent. of the forest timbers given above, in the undergrowth, which is to be the future forest of Kentucky, it falls from 40 or 50 per cent. to about 8 per cent., while its place is taken by such valueless timbers as the pin oak, black oak, Spanish oak, and black hickory. This proves that the latter timbers are of more rapid and hardy growth than the white oak, and that, in a contest for supremacy, the white oak will finally be exterminated. The extinction of our white oak would be nothing less than a calamity—one which should be avoided if possible. The white walnut is found in considerable quantities, as second growth, all through Western Kentucky near the Ohio

river. Its reddish-colored, light wood is very valuable in paneling and all ornamental works. Its bark is cathartic. The white hickory is likewise a valuable timber, found in considerable quantities, scattered all through these counties, and very extensively used in making ax-handles, hammer-handles, axletrees, and other such work. The wood is much smoother and finer-grained than that of the shagbark hickory, though the timber of the latter is likewise valuable. The larger part of the chestnut oak in Western Kentucky is of the swamp variety, though the monticola, a mountain variety of the same, is met with on the mountain tops. The former is valuable for its timber, and has a straight, unbranching trunk 40 to 60 feet high. The latter (monticola) is valuable only for its bark, which contains a large amount of tannic acid that renders it useful to the tanner. Along the line of the Paducah Railroad, where transportation facilities can be had, quite an important traffic is going on in this bark, car-loads of which are constantly shipped.

Every lumberman knows the value of the liriodendron or tulip tree. It is one of the noblest forest trees of Kentucky, with its massive, cylindrical trunk, two to five feet in diameter and forty to sixty feet long. It is found everywhere between Leitchfield and the Ohio river, after crossing the Chester shale near Leitchfield. While not quite so large a per cent. of it is found in the undergrowth as in the old forest timber, still its growth is rapid, and I see no reason to apprehend its early extinction.

The white and blue ash are also common timbers in Western Kentucky, which are exceedingly valuable. They grow best in moist, loose, sandy forests and along streams, and their wood is tough, elastic, light, and strong. They are the woods used in the best buggies and carriages, where lightness and durability are both required. The black ash is found mostly near water, in swamps and moist woods, and is largely used by the cooper in barrel-making and other such work.

The hop hornbeam (iron wood) is a very hard, tough, strong wood, and is mostly used in making levers. The sugar maples

are too well known to need mention. There are fine forests of them along the streams and in the damp woods toward the Ohio river, but little use is made of them except for local purposes. They are very rich in sap, however, and with the same industry the region might be made as historic as the sugar forests of New England.

There is a very small amount of black birch in Western Kentucky, so far as I could discover. In my entire study I only saw one or two trees, on Panther Creek. It may be common in secluded and limited localities. Its timber is very valuable and is used in the manufacture of mahogany furniture. The beeches, which exist in almost endless quantities on all the streams of Western Kentucky, are coming largely into favor in the manufacture of benches, desks, etc. The wood is the hardest found in our forests. Beside the timbers mentioned here, which are the most valuable ones, many others, varying in usefulness, were noted, a complete list of which will be found at the end of the report.

I give below, in table form, the observations made upon a belt of timber about five miles wide, stretching across all four of the counties—Grayson, Breckinridge, Hancock, and Ohio. The belt is as nearly representative as I could get it, so that the table of locations, given in the order of observation, with the per cents. of different timbers, etc., will well represent the timbers of all the counties. In location No. I, at both stations, the timber was mostly second growth, the *old* forest timber having been cut away. The small proportion of white oak among the second growth is conspicuous.

LOCATION I—STATION (A).		REMARKS.
White oak	(o. f.) 4	O. f., old forest. Y. f., young forest. 1 to 1½ miles from Leitchfield. Hill slope 7° W. Plot of ground, 2,500 square yards. Formation, Sub-carboniferous Limestone —Chester.
White oak	(y. f.) 0	
Black oak	(o. f.) 1	
Black oak	(y. f.) 41	
Pin oak	(o. f.) 0	
Pin oak	(y. f.) 57	
Post oak	(y. f.) 1	
Chestnut	(o. f.) 1	
Black gum	(y. f.) 6	

Small undergrowth of flowering dogwood, hickory, several varieties, sourwood, etc.

STATION (B).	REMARKS.
White oak (o. f.) . . . . . 2 White oak (y. f.) . . . . . 0 Black oak (y. f.) . . . . . 22 Pin oak (y. f.) . . . . . 4 Laurel oak (y. f.) . . . . . 3 Hickory (pig and shag.) . . . . . 6 Mulberry (y. f.) . . . . . 2 Ironwood . . . . . 3 Black haw . . . . . 2 Willow . . . . . 3 Dogwood (flowering) 2	Location, 1½ miles from Leitchfield. Chester formation. Hill slope 8° E. The two stations face each other like the two faces of a synclinal. Average diameter (o. f.), 1¾ feet. Average diameter (y. f.) 10 inches. Some sycamore in the region, though not found in the plot of ground chosen.

LOCATION II—STATION (A).	REMARKS.
White oak (o. f.) . 13 av. diam. . 23 in. Black gum . . . . 5 " . 7½ " Dogwood . . . . 4 " . 6 " Liriodendron . . . 3 " . 24 " Hickory (pig) . . 2 " . 10 "	Location, 8 miles from Leitchfield, on nearing the edge of the Chester shale. Note the introduction of Liriodendron, which takes place on nearing coal measures and leaving Chester. Area of plot observed, 2,500 square yards.

Small undergrowth of pin oak, black oak, Spanish oak, mulberry, dogwood, hickory, chestnut, and some maple.

STATION (B.)	REMARKS.
White oak . . . . 8 av. diam. . . 20 in. Black oak . . . . 2 " . . 28 " Spanish oak. . . . 1 " . . 26 " Pig hickory . . . . 2 " . . 23 " Sassafras . . . . . 2 " . . 7 " Black gum . . . . 1 Persimmon 1	Area 2,500 square yards. Tulip tree and pin oak occur, though not in plot of ground chosen. Location, hill-top, 145 feet above drainage.

Undergrowth: pin oak, sweet gum, sassafras, dogwood (flowering), sumach (black), hickory, persimmon, and small per cent. of white oak.

Between Location II and Location III is introduced the "sinking region," a cavernous St. Louis limestone, in which all the streams run below ground. The timber here is lirio-

dendron, redbud, mulberry, black walnut, beech, black hickory, etc.

LOCATION III—STATION (A).	REMARKS.
Post oak . . . . . 8 Black oak . . . . . 6 Spanish oak. . . . . 2 Pin oak. . . . . 1 White ash. 1	Area, 2,500 square yards. Location, 11 miles from Leitchfield, on Falls of Rough road. Formation Chester. Note the absence of liriodendron on the Chester again. Average diameter of trees, 19 inches. Some dogwood and hickory not shown in the plot. Situation, hill-top, with a long western slope.

STATION (B).	REMARKS.
White oak (o. f.) . 14 av. diam. . 21 in. White oak (y. f.) . Pin oak (y. f.) . . 15 " . 11½ " Pin oak (o. f.) . . Black oak (o. f.) . Black oak (y. f.) . 13 " . 8 " Post oak (y. f.) . . 5 " . 8 " Post oak (o. f.) . . Pig hickory (o. f.), 2 " . 16½ " Pig hickory (y. f.), 8 " . 7½ " Ironwood . . . . 1 The small bushes are about the same.	Station B is a bench of the hill slope, 2,500 square yards in area. It shows well the decrease of white oak in the young timber, as well as the timber taking its place.

LOCATION IV—STATION (A).	REMARKS.
Black sugar maple . 8 White sugar maple. 7 } av. diam. . . 22 in. Black walnut (y. f.) . 4 Sycamore (y. f.) . 2 " . . 13 " Shag. hickory . . 1 diam. . . . 24 " Chinquapin oak . . 2 Red elm (small) . . 2 Hawthorn . . . . . 3 Buckeye . . . . . 1 Willow 2	Location, lowlands on Pleasant Run, one mile from Falls of Rough. Area, 2,500 square yards. The timber here is distinctly swamp.

In the Rough Creek region hackberry and box elder, prickly ash, liriodendron, white and red elm, spicewood, hickory, three varieties, white oak, beech, and the other common forest timber, is noted. Owing to the making of two long sections off the regular belt of timber, during which I made only running notes, the next plot of ground on which I numbered and averaged the timber was about ten miles from Cloverport.

LOCATION V—STATION (A).			REMARKS.
White oak 6	av. diam. . .	19 in.	Location, hill top 10 miles from Cloverport. Area, 2,500 square yards. Pin oak, etc., are also found in the locality, though not in the plot. Undergrowth largely pin oak.
Black oak 3	" . .	24 "	
Chestnut 3	" . .	18 "	
Liriodendron . . . 2	" .	18 "	
Pig hickory 1	diam.	13 "	

STATION (B).			REMARKS.
White oak 21	av. diam. .	19 in.	Station (B) is a water shed nearly level. Area, 2,500 square yards. Pin oak, Spanish oak, and black oak are represented in the timber there, though not in the plot.
Pig hickory . . . 5	" .	18½ "	
Black gum 12	" .	10 "	
Liriodendron . . . 2	" .	17 "	
Sugar maple . . . 1	diam. . . .	18 "	

LOCATION VI—STATION (A).		REMARKS.
Dogwood (flowering) . 26	av. diam. of old timber, 25 in.	Location, near Hawesville. Area, 2,500 square yards. Formation, coal measures. Situation, level.
White oak 12		
Liriodendron 13		
Pig hickory 2		
Black oak 2		
Red oak 1		
Sassafras 1		
Black sugar maple . 1		

A little generalization from the tables, which were carefully prepared with that object in view, will give an instructive idea of the present and future conditions of the timber in Western Kentucky. For instance, restricting ourselves to the old forest growth, a little calculation shows that it is composed as follows:

White oak	40	per cent.
Post oak	7	"
Red oak	½	"
Black oak	7	"
Hickory	8½	"
Chestnut	2	"
Spanish oak	2½	"
Liriodendron	10	"
Black gum	9	"
Pin oak	½	"
Dogwood	2	"
Sugar tree	8½	"
Sycamore	1	"
White ash	1	"
Maple	½	"

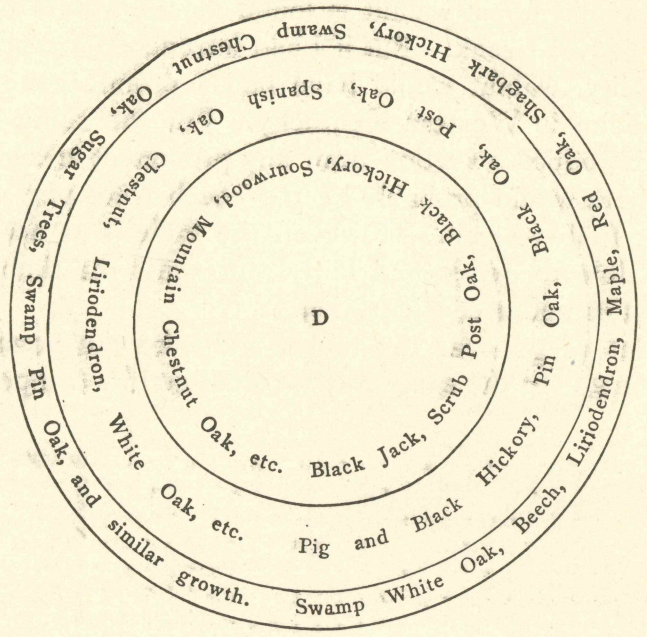
This table is not absolutely perfect, for no such tables could be. For instance, black walnut should appear in it, as a small amount of old forest walnut is found on the waters of Beech Fork of Clover Creek. But if I had introduced a section from that locality, walnut would have had a prominence which it cannot claim in Western Kentucky. For the same reason I did not introduce a section from any prominent creek bottom, where there would probably be 100 beech trees per acre, and no other timber at all. However, the table is as accurate as it is possible to get it, and fairly represents the timber of all the counties under consideration.

Now let us go over the tables and take the young forest timber only. In the same way we shall find its composition to be:

White oak	9.4	per cent.	
Post oak	3	"	nearly.
Black oak	36	"	"
Hickory	6.6	"	"
Liriodendron	2.36	"	"
Black gum	5.2	"	"
Pin oak	36	"	"
Sycamore	1	"	"
Black walnut	19	"	"

The difference between the two tables, showing the difference between the present and the coming forests, is remarkable. White oak has fallen from 40 per cent. of the old growth to a little over 9 per cent. of the young; while black oak and pin oak have risen from almost nothing in the old to 36 per cent. in the new forest. In other words, these worthless timbers are fast supplanting the white oak in Kentucky.

To these tables I shall now add a diagram showing the result of my observations in regard to the effect that height above drainage has upon the growth of timbers. While there are, of course, exceptions to this arrangement, still it is the most general expression of the distribution of timber, with reference to drainage, that can be given. The hills are so low in Western Kentucky that the points of the compass produce no appreciable effect on the timber:



If the hill, D, be divided into three belts, as in the diagram, each belt will be seen to have a growth somewhat peculiar to itself, wholly dependent upon its height above drainage. The timbers peculiar to each are indicated in the diagram. It will be noticed that the belt at the base of the hill is the narrowest, showing that, as a rule, swamp timbers do not extend very high above drainage. The middle belt of timber is the widest. The reason is, that timbers on a hillside change but little after leaving local drainage, until the rocky outcrops or the poor, thin shales near the top of the hill are reached. These shales or rocky cliffs, again, have their own timbers, the whole making three tolerably distinct belts, which can be easily traced on any considerable hill.

I also give below, condensed into table form, a complete list of the trees met with in my study:

ORDER CUPULIFERAE—MASTWORTS.

1. *Genus Quercus.*
   - White oak, Quercus alba (L.)
   - Red oak, Q. rubra (L.)
   - Pin oak, Q. palustris (Mx.)
   - Spanish oak, Q. fulcata (L.)
   - Black oak, Q. tinctoria (Bart.)
   - Post oak, Q. obtusiloba (Mx.)
   - Black jack, Q. nigra (L.)
   - Swamp laurel oak, Q. laurifolia (Mx.)
   - Swamp white oak, Q. bicolor (Willd.)
   - Chestnut oak, Q. castanea (Muhl.)
   - Swamp chestnut oak, Q. prinus (Willd.)
   - Var. monticola (Michx.)
   - Dwarf chestnut oak, Q. prinoides (Willd.)
2. *Genus Castanea.*
   - Chestnut, Castanea vesca (L.)
3. *Genus Fagus.*
   - Common beech, Fagus sylvatica (L.)
   - Red beech, F. ferruginea (Ait.)
4. *Genus Ostrya.*
   - Hop hornbeam or ironwood, Ostrya virginica (Willd.)

ORDER SALICACEÆ—WILLOWWORTS.

1. *Genus Salix.*
   - Basket osier, Salix riminalis (L.)
   - Green osier, S. petiolaris (Smith.)
   - Purple willow, S. purpurea (L.)
2. *Genus Populus.*
   - Western cotton tree, Populus angulata (Ait.)
   - American aspen, P. Tremuloides (Mx.)
   - Balm of gilead, P. candicans (Ait.)
   - Silver leaf poplar, P. alba (L.)

ORDER BETULACEÆ—BIRCHWORTS.

1. *Genus Betula.*
   - Black birch, Betula lenta (L.)
   - Red birch, B. nigra (Ait.)

2. *Genus Alnus.*
   Smooth alder, Alnus serrulata (Willd.)

ORDER JUGLANDACEÆ—WALNUT.

1. *Genus Juglans.*
   White walnut, Juglans cinerea (L.)
   Black walnut, J. nigra (L.)
2. *Genus Carya.*
   Shagbark hickory, Carya alba (Nutt.)
   Shellbark hickory, C. sulcata (Nutt.)
   Mockernut, C. tomentosa (Nutt.)
   Pignut hickory, C. glabra (Sorr.)
   White hickory, C. microcarpa (Nutt.)

ORDER PLATANACEÆ—SYCAMORE.

1. *Genus Platanus.*
   Sycamore, plane tree, Platanus occidentalis (L.)

ORDER OLEACEÆ—OLIVES.

1. *Genus Fraxinus.*
   White ash, Fraxinus americana (L.)
   Blue ash, F. quadrangulata (Mx.)
   Black ash, F. sambucifolia (Lam.)

ORDER ULMACEÆ—ELMWORTS.

1. *Genus Ulmus.*
   Slippery elm (Red elm), Ulmus fulva (L).
   White elm, U. americana (L).
   Cork elm, U. racemosa (L.)
   Winged elm (Whahoo), U. alata (Mx.)
2. *Genus Celtis.*
   Hackberry, Celtis occidentalis (L.)

ORDER CORNACEÆ—CORNELS.

1. *Genus Cornus.*
   Flowering dogwood, Cornus florida (L.)
   Low cornel, C. canadensis (L.)
2. *Genus Nyssa.*
   Black gum, Nyssa multiflora (Wang.)
   Swamp black gum, N. uniflora (Walt.)

ORDER LAURACEÆ—LAURELS.

1. *Genus Sassafras.*
   Common sassafras, Sassafras officinale (Nees.)
2. *Genus Benzoin.*
   Spicewood, Benzoin odoriferum (Nees.)

ORDER ROSACEÆ—ROSEWORTS.

1. *Genus Cerasus.*
   Black cherry, Cerasus serotina (D. C.)
2. *Genus Prunus.*
   Red and yellow plum, Prunus americana (Misch.)
3. *Genus Cratagus.*
   Hawthorn (not a native) Cratagus oxycantha (L.)

ORDER ARTOCARPACEÆ—ARTOCARPS.

1. *Genus Morus.*
   Red Mulberry, Morus rubra (L.)

ORDER LEGUMINOSÆ.

1. *Genus Gleditschia.*
   Honey locust, Gleditschia triacanthus (L.)
2. *Genus Robinia.*
   Black locust, Robinia pseudacacia (L.)
3. *Genus Cercis.*
   Redbud (Judas tree), Cercis canadensis (L).

ORDER ACERACEÆ—MAPLES.

1. *Genus Acer.*
   Red maple (trident), Acer rubrum tridens (L).
   White maple, A. dasycarpum (Ehrh.)
   Sugar maple, A. saccharinum (L).
   Black sugar maple, A. nigrum (Mx.)
2. *Genus Negundo.*
   Box elder, Negundo aceroides (Moench).

ORDER SAPINDACEÆ—SOAPWORTS.

1. *Genus Æsculus.*
   Ohio buckeye, Æsculus glabra (Willd.)

ORDER ANACARDIACEÆ—SUMACHS.

1. *Genus Rhus.*
   Smooth sumach, Rhus glabra (L.)
   Large sumach, R. typhina (L.)

ORDER RUTACEÆ—RUEWORTS.

1. *Genus Xanthoxylum.*
   Prickley ash, Xanthoxylum americanum (L.)

ORDER BIGNONACEÆ—TRUMPET FLOWERS.

1. *Genus Catalpa.*
   Catalpa, Catalpa bignonioides (Walt.)

ORDER MAGNOLIACEÆ.

1. *Genus Liriodendron.*
   Tulip tree (erroneously called yellow poplar), Liriodendron tulipfera (L.)

ORDER BERBERIDACEÆ.

1. *Genus Berberis.*
   Berberry, Berberis vulgaris (L).

ORDER ANONACEÆ.

1. *Genus Asimina.*
   Common papau, Asimina triloba (Dunal).

ORDER HAMAMELACEÆ—WITCH HAZELWORTS.

1. *Genus Liquidambar.*
   Sweet gum, Liquidambar styraciflua (L.)

ORDER EBENACEÆ.

1. *Genus Dyospyros.*
   Persimmon, Dyospyros virginiana (L.)

ORDER ERICACEÆ.

1. *Genus Oxydendrum.*
   Sorrel tree, Oxydendrum arboreum (D. C.)

ORDER CAPRIFOLIACEÆ.

1. *Genus Sambucus.*
   Pith elder, Sambucus canadensis (L.)
2. *Genus Viburnum.*
   Black haw, Viburnum prunifolium (L.)

ORDER CALYCANTHACEÆ.

1. *Genus Calycanthus.*
   Sweet shrub, Calycanthus floridus (L.)

GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT

ON THE

TIMBERS OF THE NORTH CUMBERLAND:

BELL AND HARLAN COUNTIES.

BY LAFAYETTE H. DEFRIESE.

STEREOTYPED FOR THE SURVEY BY MAJOR, JOHNSTON & BARRETT, YEOMAN PRESS, FRANKFORT, KY.

INTRODUCTORY LETTER.

Professor N. S. SHALER, *Director Kentucky Geological Survey:*

DEAR SIR: I herewith send you a report on the timbers of the North Cumberland, which is a continuation, both in method and purpose, of a previous report on the timbers of four counties of Western Kentucky. The study upon which the present report is based was made during July and August, 1876, and was sufficiently exhaustive to insure accuracy and a reasonable degree of completeness.

Very respectfully,

LAFAYETTE H. DEFRIESE.

NEW YORK, March 20, 1877.

REPORT ON THE TIMBERS OF THE NORTH CUMBERLAND—BELL AND HARLAN COUNTIES.

The method of study pursued in investigating the timber of the North Cumberland necessarily differed somewhat from that indicated in a former report on the timbers of Grayson, Breckinridge, Hancock, and Ohio counties.* The reason is, that the latter counties are comparatively level, are largely settled, and their timbers had to be studied with reference to the effects which clearing away the old forests would have upon the future timber growth of the counties. In the present report, on the contrary, the country is almost impassably mountainous; comparatively a very small proportion of land has been cleared, and the mountains are still crowned by their vast and primitive growths. The end to be attained in this report is, evidently, to give a conception as clear as possible of the present condition of these timbers. I have, therefore, not done so much plotting of ground and numbering of trees as was given in the former report; for it is manifestly very difficult, if not impossible, for the mind to pass from the consideration of a few detached and poorly representative plots of ground, of a few hundred square yards each, to the comprehension of a vast forest whose area comprehends millions of acres.

Another difficulty lies in the way of giving a clear impression of the timbers under discussion. They grow upon a perfect net-work of mountains. There is no regular gradation of timbers on these mountain chains; so no fairly representative one can be chosen and studied which will give data for a report upon, and a clear comprehension of, the whole. On the contrary, the mountains are sharply divided into those whose forest must rank among the finest in this or any other country and those whose timbers are, at best, only tolerably good, often mediocre. There are no intermediate chains. To the former class belong the Black Mountain and its spurs; to the latter class, the Brush, Pine, and Cumberland mountains. I tried to find out the reason of this extraordinary difference in the timbers of mountain ranges which are all intermingled, and whose geological composition is essentially the same. My opinion is, that the difference is due to the position of the underlying rocks. In the Pine, Cumberland, and Brush mountains these rocks have an average dip of 14° to 25°. The result is, that in passing up one face of the mountain we climb directly up the dip, which so nearly coincides with the slope of the mountain that the beating of summer rains and the action of winter snows keep the soil washed off nearly down to the rocks themselves, leaving no ground for the roots of a massive forest growth to take hold and flourish in. The result is a stunted growth of hardy trees, whose roots are spread out on the surface of the barely covered rock below, such as mountain chestnut oak and rather small sizes of chestnut, red oak, pin oak, and the various pines. On going down the opposite side of these mountains, the continual masses of outcropping rocks, forming a steep and precipitous descent, leave no room for other timbers than the *Rhododendron* (wild rose bay), *Kalmia latifolia* (American laurel), and such shrubs as cling to the faces of rocky cliffs.

On the Black Mountain and its spurs, on the other hand, the rocks are horizontal, and the slowly accumulating detritus clings to their surfaces, whose position opposes the slope of the mountain at such an angle as to hold the detritus in place. A loose soil accumulates, in which an abundance of forest weeds spring up, and the decay of leaves and of these annually dying weed-tops constantly adds richness and depth to the soil already in position. The consequence is, that, in the parts of the Black Mountains familiar to me, even on the steepest slopes, there is a rich alluvial soil of from two to four feet in depth. For this reason, there is a growth of chestnut, tulip tree (yellow poplar), black walnut, white and

*See report on the timbers of those counties.

blue ash, birch, linden, and white hickory, that I have never seen surpassed.

As no mountain could be chosen for study which would fairly represent the timber of the country, my method was to make sections across Black Mountain and its spurs, and also across Brush and Pine Mountains. I chose some as nearly representative locality as possible at which to cross the mountains, and at every hundred barometric feet in height, more or less, I noted the proportion, size, and condition of growth of all the timber distinctly visible from that point. This method will, of course, give the height above drainage at which any species disappears or is introduced. I tried also to get the proportional effects of alluvial soil and of nearness to water upon what are known as swamp timbers. It is well known that some timbers are found only on bottom lands, and never appear very high above water-level; but, whether this fact is due more to the presence of the detritus from the hills, which always forms an alluvial soil along the streams, or whether the presence of water is absolutely essential to their growth, I was not able to determine. In the former case, the same timbers would grow on such soils, whether close to water or not. An experiment, showing whether these swamp timbers will grow on alluvial soils high above water, or whether they will grow near water without an alluvial soil, would be very interesting. My own opinion is, that the soil, not the water, is the essential part with most of them. I was led to this opinion by noticing that little benches, high up on the mountains, where there is no constant drainage, but where deep alluvial soil has accumulated, grew most of the swamp timbers; but, as a certain amount of water always found its way during rains into these depressions, it was impossible to get data enough to warrant more than a mere conjecture.

In regard to the relation between the old and the young forest growths in this region, with the exception of walnut timber and of other timbers in certain localities, I see no reason why the present proportions between the two should be materially changed in the near future.

The walnut timber is as ruthlessly destroyed in Eastern as in Western Kentucky. I saw a magnificent walnut tree, forty inches in diameter, with a trunk of more than fifty feet in length, cut for rails—a tree worth hundreds of dollars sacrificed for a few panels of fence. No care whatever is taken either to preserve the old forest walnut now standing or to encourage the young growth. Besides this, except in certain localities, there is a practice of yearly "burning off the woods," which is doing almost irreparable injury to the forests in those parts of Black and Brush mountains where the timbers are finest. Especially in the Black Mountains, there is a very heavy growth of weeds that yearly die down, and, with the fallen leaves, make a perfect mass of highly combustible material. Late in the fall, when these are driest, they are set on fire, and the heat is great enough to kill every bush that has appeared during the year. As this is done year after year, there is no chance whatever for a young forest growth to start. The consequence is, that in those parts of Black Mountains where the present forests are most dense and valuable, there is not a single young tree or bush to be found. In many places this practice has been going on so long that the old forest is rapidly dying out with age, and there is nothing coming on to take its place. If the practice of burning off the mountains is not stopped immediately, at any rate long enough for a new forest to get a permanent hold, so that fire cannot destroy it, before many years a mountain as rich in valuable timbers as any I know of in this country will be almost, if not entirely, stripped of its precious products. Some extra care should certainly be taken to preserve and perpetuate so rich a forest of such timbers as black walnut, black, white, and blue ash, white hickory, tulip tree, black birch, etc. So valuable are the ashes and the white hickory now becoming, that a Paris carriage manufacturing firm is thinking seriously of establishing a spoke factory in some part of Kentucky, where these timbers can be most easily obtained. Already there is a very large trade going on in *Liriodendron* or tulip tree (called yellow poplar) timber,

logs of which are cut from the mountains and floated down the Cumberland in immense numbers every winter. However, I see no reason to apprehend any near exhaustion of this timber, if more care is taken to prevent the killing of the young growths by fire, which certainly should be done. At least a dozen species of the most valuable timbers in the markets of the world now grow in large quantities on the Black Mountain ridges. Their extinction would be even more than a State calamity. In fact, Kentucky alone might, at the expense of a few hundred dollars, have exhibited at Philadelphia, in 1876, a collection of timbers which would have rivaled the timber exhibit of any foreign country in the quality, variety, and value of its woods.

I deem it best, before commencing a more minute consideration of the effect of different soils, height above drainage, etc., upon different timbers, to refer generally to some peculiarities that struck me, in the distribution and growth of certain varieties of trees. As black walnut is the most valuable of the timbers, I shall commence with that. I made a section across Black Mountain, starting on the Cumberland river, at Hezekiah Hall's, not far from the dividing line between Bell and Harlan counties. My barometer, at the starting point, stood 1,870. At a height of about 1,300 barometric feet above the datum point, and about 500 barometric feet below the crest of the mountain, I found a remarkable belt of the finest old-forest walnut timber that I have ever seen. The trees are more scattering now in this belt than they have been; for the trunks of several of the finest, which had fallen during the year, were still lying there. There is no undergrowth of any kind whatever to be found within the compass of this belt, owing to the practice before mentioned of burning off the woods yearly. The belt to which the walnut timber is almost wholly confined, here, is only of the width covered by a height of a little more than 100 barometric feet; that is, at the lower edge of the belt my barometer registered about 3,100, and at the upper edge about 3,240. On a steep mountain side this forms a very narrow strip of ground. About

300 barometric feet below this walnut belt I noted a bed of outcropping coal sixteen inches thick. The walnut itself is growing on a very rich loamy soil, partly detritus and partly decayed vegetable matter, about two feet deep, almost entirely devoid of undergrowth of trees, but perfectly matted with a rank growth of forest weeds, fully ten feet high in places. This walnut-growing belt winds along the mountain as far as I had time to trace it (which was not very far, however), always at about the same height above the river below. I noticed that it was just under the top crest of the mountain, and crossed precisely at the heads of the various little streams that flowed from under that crest and made their way to the river below. One of the many magnificent walnut trees that I found in this peculiar belt was fourteen feet six inches in circumference, with a curling but straight and beautiful trunk, sixty feet in length. In an area of twelve hundred and fifty square yards in this belt the principal timbers were:

Black walnut	6;	average diameter	40 inches.
Buckeye	5;	"	29 "
White ash	3;	one of them with diameter	34 "
Linden	6;	average diameter	23 "

But this plot of ground was a choice one. There is not such an average of walnut as that even in the belt here spoken of.

Another case of peculiarity in the growth of certain timbers which I noted, is that of the hemlock (*Abies canadensis*) of Eastern Kentucky. In this part of the country the hemlock is confined wholly, so far as I know, to Conglomerate formations; so that the presence of this timber, in any locality in this part of Kentucky, is a guarantee that the geological formation there is Conglomerate. Of course, in other parts of the country, hemlock grows on other than Conglomerate soils; and of course, too, not all Conglomerate soils of Kentucky grow hemlock. Through all the coal regions of Western Kentucky I never saw a single tree of it. But not only is the hemlock of Eastern Kentucky confined to Conglomerate formations; it is also never found very high above local drainage. In the whole course of Cumberland river, from Cumberland Gap to near its head waters, and on all the

various small streams that rise in Brush, Black, Pine, and Cumberland mountains, and flow into Cumberland river, I have never seen a single hemlock more than one hundred barometric feet above local drainage, except in one spot. That was shortly after crossing the Harlan county line in ascending the Cumberland, where I found some hemlock trees on top of the bluff, that here rises precipitately from the river to a height of two hundred feet. But even in this case, although the trees are two hundred barometric feet above the river, on the opposite side of the hemlock from the river is a considerable depression, through which a branch runs most, if not all, of the year; so that this is not strictly an exception to the statement that I never saw a hemlock, in this part of Kentucky, growing more than one hundred feet above local drainage. So far as my observation extends, therefore, the presence of a hemlock tree in Kentucky proves two things: Conglomerate formation, and water, present part of the year at least, within one hundred barometric feet.

The last peculiarity of growth that I shall notice here, is that of the white oak. In a former report on the timbers of some parts of Western Kentucky (volume II, page 339) I mentioned the want of hardihood in the white oak, inferred from the fact that Spanish oak, red oak, pin oak, etc., when left to free competition with the white oak, in the course of time choke it out and supplant it. In Eastern Kentucky, where the mountains are sufficiently high for exposure to different points of the compass to produce a marked effect on the timbers, I found a confirmation of my former opinion in regard to the comparative sensitiveness of the white oak. In making a section across Black Mountain, along what is called Hall's branch, not far from the Harlan county line, the hills on either side of the hollow are quite steep and high, and form a synclinal, one face of which is exposed to the north, the other to the south. The formation and soil of the two faces were exactly the same, so far as I could see, and both were heavily timbered. But on the hillside exposed to the south about forty-five per cent. of the whole timber was of

the most massive and splendid white oak, often four feet in diameter and ninety feet high. Here there was less than one per cent. of *Liriodendron* (yellow poplar, so-called). On the northern exposure opposite, on the contrary, about thirty-five per cent. of the timber was massive *Liriodendron*, many trees of which were six and seven feet in diameter, with trunks sixty to eighty feet high. Here the white oak formed less than one per cent. Of course this is a very striking example, and it could not be said that difference of exposure everywhere in these mountains produces such a marked effect upon the white oak. But altogether, my observations convinced me beyond a doubt that the white oak is not so hardy a tree as it is often supposed to be.

There are not many valuable timbers in Eastern Kentucky which I have not already noticed in a former report on Western Kentucky timbers. Of course the black walnut, already noticed, and the black birch, of which there is a considerable quantity scattered through the Black and Brush Mountains, are the most valuable timbers. But, as in Western Kentucky, the people seem to attach very little importance to either. The *Liriodendron* is largely floated out every winter, as I mentioned before, for lumber. The white hickory and black and blue ash rank next in value; and they all abound, in the Black Mountain especially. Owing to the abundance of water-power, the accessibility, in large quantities, of these timbers, and their great demand in carriage-making, I see no reason why the near future should not see many spoke factories, ax-handle and hammer-handle factories, and carriage factories, in this part of Kentucky. Already the eyes of some large carriage factories are turning toward these timbers, and they only need to be better known in order to become a good source of revenue to the people. The red maple, which is growing more and more into favor in cabinet work, also abounds in Bell and Harlan counties. The linden (*Silia Americana*) is also found in large quantities through these mountains, and is very valuable in cabinet work, paneling, etc. The pines, especially the pitch pine (*Pinus rigida*)

and the yellow pine (*Pinus mitis*), are very abundant in parts of the mountains, particularly Pine Mountain. They are too well known to need especial mention, except to say that not a pine is to be found in those counties of Western Kentucky, on which my former report was made, so far as I could discover. I know of no especial reason for their total absence from that part of Kentucky. Certainly the want of mountains in Western Kentucky is not a sufficient explanation; for pine woods are often low and flat, though I do not know of any in Kentucky that are so. Other timbers found in Eastern Kentucky, that do not grow in such parts of Western Kentucky as I have studied, are the magnolias (*Magnolia acuminata*, *M. umbrella*, and *M. fraseri*), hemlock, *Rhododendron* (*maximum*), and American laurel (*Kalmia latifolia*).

I shall now proceed to give in detail the most important of the sections made, in the order in which they were made. Between ten miles above Pineville and Browning creek the exposure of the mountain facing the river shows *Liriodendron*, hemlock, beeches, chestnut, red oak (called often water oak by the people), the three magnolias given above, *Rhododendron* (*maximum*), American laurel, red and white maple, trident red maple, white oak, pines (*mitis* and *rigida*), the various hickories (mostly shell-bark), dogwood, sourwood, and Stuartia (*Stuartia virginica*).

A section was made up Browning creek to Brush Mountain, and across Brush Mountain to Cumberland Mountain. Up Browning creek, to the last crossing before starting up Brush Mountain, the timbers noted were white oak (which predominates), pin oak, pig hickory, chestnut oak, mulberry, red elm, buckeye, papaw, sycamore, shag hickory, white walnut (in considerable quantities), black walnut (small quantity), white ash (very fine and large), grey birch, linden (*Tilia Americana* and *T. heterophylla alba*), white elm, black cherry (only one or two), winged elm, white hickory, the magnolias, hemlock, sweet gum, and black sumach. I should say here that, in making sections through the mountains, I give the timbers, not in the order in which they probably predominate, but in

the order in which they are met with. This is very necessary, especially in going up a steep mountain side, as it marks the height above drainage at which different timbers grow.

In starting up Brush Mountain, the timbers remained substantially the same for a barometric height of four hundred and sixty feet. They are the magnolias, chestnut, hemlock (for the first fifty feet only), black gum, white oak, white maple, beech, tulip tree, black hickory, grey birch, black oak, pin oak, red oak, white hickory, sycamore (along Middle Branch), black walnut (in small quantities), white walnut, holly, black locust, red elm, shag hickory, and red maple (very large). The formation is conglomerate. At a height of four hundred and sixty feet chestnut oak is first seen. There are also black ash, red oak, witch hazel, and scattering pines.

Timbers.	Height in barometric feet.	Remarks.
Pines, chestnut, chestnut oak, black gum, and rock maple .	720	The absence of all the other timbers here is due not so much to height as to vicinity of a slide, which had precipitated the crest of the mountain down to nearly this height.
Pines (*P. mitis* and *P. rigida*) . .	965	Here we come to a bluff that has fallen from the top of the mountain, and hence the absence of all timber except dwarf pines. This throw lasts for a height of three hundred feet.
Black locust, chestnut, chestnut oak, black birch, magnolia cucumber, pin oak, *Liriodendron*, sweet pepper, etc.	1300	At this height the fall from the mountain top is crossed, and we again find the timbers that normally belong to the mountain side. All of these timbers are very heavy.
Chestnut oak almost entirely . .	1600	Here we meet with another slide from the mountain top, which normally belongs just below the one at a height of 965 feet. Very evidently that was originally the mountain crest, and fell first. This underlay it, and fell at a later date. Geology shows plainly that both have fallen; but their relative positions originally I argue from the botany alone.

Timbers.	Height in barometric feet.	Remarks.
Pin oak, black oak, pig hickory, *Liriodendron*, chestnut, and chestnut oak	1940	The mountain top here is level and broad, showing the slide of the rock cliffs that once capped it. So the timber here is not that which geologically belongs to the top of the mountain.

An irregular spur of the Black Mountain, almost at right-angles to the last section, gives, on its southern exposure, the following timbers:

Timbers.	Height in barometric feet.	Remarks.
Sweet gum, beech, red maple, shag hickory, black hickory, white oak (very massive), holly, *Liriodendron*, black locust, magnolia umbrella, black gum, white walnut, grey birch, black oak, and chestnut	base.	The character of the undergrowth here is somewhat different. It consists of azaleas, mountain oak, red oak, chestnut, dogwood, and some white oak, hickory, etc.
Liriodendron, white oak, shag hickory, water beech, black oak, red maple, black hickory, white maple, chestnut, june-berry . . .	100	It will be noticed that sweet gum, the magnolias, and holly disappear during the first hundred feet.
White oak, water beech, chestnut, witch hazel, *Liriodendron*, june-berry, black locust, black oak, pig hickory, rock maple, post oak, sourwood, dogwood, etc.	200	The shag bark hickory here disappears.
Mountain chestnut oak, black oak, white and rock maple, *Liriodendron*, white oak, pig hickory, dogwood, etc.	300	Here the undergrowth becomes very heavy, black oak and red oak predominating. Mountain chestnut oak makes its first appearance also.
Rhododendron maximum, mountain chestnut oak (in great quantities), pine (*mitis*), black hickory, American laurel, sourwood, etc.	330	A cliff of horizontal sandstone here changes the character of the timber almost completely.

Timbers.	Height in barometric feet.	Remarks.
Dwarf chestnut oak, dwarf pine, dwarf and post oak, rock maple, sourwood, and American laurel	400	The sandstone cliff here still continues, but at a dip of 14°. It evidently belongs to the mountain top, but has slid down, for the rocks of Black Mountain are horizontal in their normal position.
White oak, chestnut oak, chestnut, black gum, and pin oak are the old growths	560	These timbers evidently belong to a position geologically below the 400-foot level.

In passing up the Cumberland from White Rock toward Mount Pleasant, the timbers are mostly white oak, beech, chestnut, red oak, Spanish oak, maple, etc., except where a ridge of the mountain juts down to the river, when pin oak, pines, mountain chestnut oak, black oak, etc., are introduced. Shag and white hickories are plenty along the bases of the mountains, pig and black hickories higher up. Hemlock abounds all along the little streams, to a height of fifty barometric feet above drainage.

After crossing over into Harlan county, I made a section to the top of Black Mountain, up Gray's branch, and came down a different way, so as to get two sections. The results are here given in detail:

Timbers.	Height in barometric feet.	Remarks.
White oak, black oak, red oak, black gum, black walnut, maples, beeches, etc.	base.	The walnut timber here is only young growth, confined to open spots.
Beech, sugar maple, white maple, *Liriodendron*, red oak, linden, black gum, white oak, white hickory, shag hickory, grey birch, and blue ash	100	The mere list of trees here gives no idea of the splendor of the forest. The *Liriodendrons* are five to seven feet in diameter, with trunks sixty to eighty feet long. The white oak timber is also extremely heavy, and the blue ash as fine as any I ever saw.

Timbers.	Height in barometric feet.	Remarks.
Grey birch, beech, white maple, *Liriodendron*, blue ash, buckeye, red oak, black gum, spicewood, magnolia umbrella, etc. . .	200	No perceptible change in the splendor of the forest.
Liriodendron, chestnut, shag hickory, red oak, beech, white oak, linden, maple, dogwood, etc. .	340	The linden is yet scattering, as it is found mostly in this part of Kentucky high up on the mountain side. The timbers are all heavy.
Liriodendron, chestnut, shag hickory, red bud, red maple, linden, june-berry, etc.	480	The *Liriodendron* remains as heavy as ever. The shag hickory is also very fine.
Growth same as above, with the addition of ironwood.	580	The linden first becomes very abundant at this height in ascending the mountain.
Liriodendron, chestnut, white ash, white hickory, red oak, linden, buckeye, ironwood, dogwood, etc.	700	Linden, chestnut, and *Liriodendron* are the chief timbers at this height.
Liriodendron, chestnut, white ash, blue ash, and most of the 700-feet timbers	850	At this height a sixteen-inch vein of coal crosses the hollow. The blue and the white ash are very fine indeed.
Black walnut, chestnut, *Liriodendron*, white hickory, linden, buckeye, etc.	1050	The splendor of the forest here can hardly be imagined. The belt of walnut before mentioned begins to show itself here, while the *Liriodendron*, chestnut, and white hickory are of the finest.
Black walnut, buckeye, *Liriodendron*, white ash, sugar maple, linden, white hickory, etc. . .	1250	At this height crosses the curious belt, 25 per cent. of whose timber is old forest walnut. In size and quality these trees have no superior in this country, so far as I know.
Chestnut, red oak, rock maple, black locust, pig hickory, etc.	1375	The walnut timber gives out below this height, and a ledge of rock here gives high mountain timbers. Linden gives out above this height.

Timbers.	Height in barometric feet.	Remarks.
Red oak, buckeye, blue ash, white hickory, *Liriodendron*, chestnut, black birch, shag hickory, pin oak, etc.	1600	The ledge of rock above mentioned is crossed before reaching this height. The growth of white hickory so far above drainage is noticeable. It can be met with only on the richest ground at this height.
Chestnut (dwarf), pin oak, white oak (dwarf), black gum, American laurel, rock maple, sourwood, etc.	1790	Here the top of the mountain is reached, as the timbers indicate. The fact that there is so little change of timbers, where the differences of level are so great, shows that the underlying rocks are horizontal and hold the soil, so that it forms a rich loam from the bottom to the top of the mountain.

Notice here that this is not the height of the mountain above the river below, but only its height above the point at which I started up it, which was some three hundred feet above the river level.

In passing down the mountain by a different route, but few variations from the above tables were met with. The "sweet shrub" was one of these. The belt of walnut was found encircling the mountain at about the same height as given above.

The timbers on a spur of Black Mountain shooting off near the last section will suffice to give the differences between the timbers of the main range and one of its spurs:

Timbers.	Height in barometric feet.	Remarks.
White oak, black oak, red maple, beech, buckeye, black hickory, black gum, linden, etc.	base.	The exposure here is south, and white oak is by far the predominant timber. It is not usual to see linden so low, and only one tree was found here.
Buckeye, black walnut, white oak, *Liriodendron*, chestnut, pig hickory, linden, and sugar maple .	120	White oak still predominates. A small amount of black walnut, not more than twenty inches in diameter. Only one linden tree.

Timbers.	Height in barometric feet.	Remarks.
White oak, blue ash, black oak, linden, chestnut, pig hickory, sourwood, chestnut oak, water birch, maple, etc.	250	White oak is here reduced in size and importance. Linden is more plenty, and the first chestnut oak appears.
Chestnut oak, june-berry, black hickory, sourwood, white maple, and black oak	300	Here white oak almost wholly disappears, as well as ash and linden.
Chestnut, chestnut oak, black oak, sourwood, dogwood, black gum, etc.	400	Here the timber is almost wholly chestnut oak, and evidently belongs higher up than that found upon the top of the bench given below.
White oak, white and pig hickory, black locust, black walnut, red maple, black oak, *Liriodendron*, etc.	500	The timber on top of this bench of the spur is fully equal to that at its base. I had not time to cross completely over the spur.

A section made on a spur of Pine Mountain, two miles below Mount Pleasant, gives the timbers mentioned below:

Timbers.	Height in barometric feet.	Remarks.
White oak, beech, black oak, *Liriodendron*, white sugar maple, red oak, sourwood, chestnut, black gum, grey birch, etc. .	100	The timber on Pine Mountain, at its most favorable points, is scrubby and ordinary. It is so even here at its base.
Chestnut oak, chestnut, black oak, *Liriodendron*, dogwood, black gum, sourwood, and grey birch	250	Here the mountain side is a perfect talus mass of fallen stones and débris. Timber more or less dwarf. White oak and beech have disappeared.
Rhododendron (maximum), chestnut (dwarf), sourwood, mountain oak (dwarf), etc.	350	Here there is a vast cliff of sandstone, dipping 22½° west southwest, from which the talus above was thrown. Timbers all dwarf. The cliff is about eighty feet high. *Liriodendron* disappeared at the cliff mentioned above.

Timbers.	Height in barometric feet.	Remarks.
Pine (*P. mitis*,) chestnut and chestnut oak (both dwarf), dogwood, sourwood, and American laurel	500	This is the top of the spur. Timber is all small—pine predominates.

I now give a section across Pine Mountain proper. It is triple-crested at this point (two miles below Mount Pleasant); that is, it is composed of three mountains, as it were, mashed in together, with their tops all distinct. The southern exposure is a very long and gentle slope, so that almost half a mile is sometimes gone over in a single hundred barometric feet.

Timbers.	Height in barometric feet.	Remarks.
White oak, black oak, chestnut, maple, *Liriodendron*, hickories, etc.	base.	Along the base of Pine Mountain here the timbers are very good—often, indeed, quite heavy.
Chestnut, chestnut oak, white oak (in small quantities), pin oak, black oak, pine (*P. mitis*), etc.	200	The chestnut here is very large, while the white oak is small and has almost disappeared.
Pine (*P. mitis*), chestnut, chestnut oak, black oak, and other timbers about as last	340	Very little change of timber from the level above, except that white oak has wholly disappeared on the first spur or crest of the mountain.
Mountain chestnut oak, scrub oak, American laurel, chestnut oak, chestnut, black oak, etc. . . .	430	Here there is quite a change in the timbers, chestnut and black oak growing scarce and other timbers coming in. Undergrowth very heavy—pin oak, hickory, black oak, pine, etc.
Mountain chestnut oak, American laurel, black gum, pine, chestnut, etc.	550	Here we reach the top of the first crest. The timber is almost wholly chestnut oak.
White oak, chestnut, black oak, and pine	520	This is a divide between two crests, is lower down barometrically than the last station, and gives very heavy white oak and chestnut timbers.

Timbers.	Height in barometric feet.	Remarks.
Chestnut oak, black gum, sourwood, pine (*P. mitis*,) etc. . .	790	The timber here is again that of a high mountain side. The mountain slopes only 7° southeast.
Timber precisely the same as above.	1050	Another mountain crest. The slope of the mountain between these two points has been so gradual that no change in timber has taken place.
Chestnut, white oak, black locust, and chestnut oak	1030	This is a low divide between two crests again, and the chestnut and white oak are very heavy.
White oak, chestnut, grey birch, sugar maple, hickories, etc. . .	1185	This is the mountain top at this point; but in reality it is a gap in the mountain where the distance down to Beech Fork, on the north side, is only a few hundred feet.

The south exposure of Pine Mountain, as given above, is a gradual slope, whose steepness is just equal to the dip of its rock, and is about five miles long. On the north side, on the contrary, the rocks jut out, forming an almost precipitous descent to the waters of Beech Fork, at the base of the mountain. On the north side, where the rocks are not too precipitous, red oak, *Liriodendron* (very heavy), ash, and hickories are found. The total absence of *Liriodendron* on the south exposure, except right at the base of the mountain, and the total absence of white oak on the north exposure, deserve careful notice.

By merely glancing through the tables given above, it will be seen that, as a rule, subject of course to exceptions, near the base of a mountain such timbers as white oak, beeches, black ash, the magnolias, *Liriodendron* (yellow poplar), red oak, white and shag hickory, etc., are found. That none of these timbers, except the *Liriodendron*, reaches half way up the mountain, but are gradually replaced by chestnut, black oak, pin oak, pig and black hickory, linden, etc. That most

of these again give out on nearing the top of a mountain, and mountain oak, dwarf chestnuts, the pines (especially *P. mitis* and *rigida*, or yellow and pitch), etc., take their places. That the most marked change dependent upon exposure to different points of the compass is found in the case of the *Liriodendron* and white oak, the former flourishing most on northern exposures, the latter on southern. That the principal change noted in this part of Kentucky, due to geological formation, is furnished by the hemlock, which is found only on Conglomerate soils. These and other minor inferences can be deduced from a study of the tables.

The difference between the timbers of Eastern and Western Kentucky is not marked enough to be worthy of special notice beyond what has been given to it in previous pages. So it only remains to give a table of all the timbers met with in Bell and Harlan counties, which will be found below:

ORDER CUPULIFERÆ—MASTWORTS.

1. *Genus Quercus.*
   - White oak, Quercus alba (L.)
   - Post oak, Q. obtusiloba (Mx.)
   - Chestnut oak, Q. castanea (Muhl.)
   - Red oak, Q. rubra (L.)
   - Black oak, Q. tinctoria (Bart.)
   - Pin oak, Q. palustris (Mx.)
   - Scrub oak, Q. illicifolia (Willd.)
   - Dwarf chestnut oak, Q. prinoides (Willd.)
   - Spanish oak, Q. falcata (L.)
   - Swamp white oak, Q. bicolor (Willd.)
2. *Genus Castanea.*
   - Common chestnut, Castanea vesca (L.)
3. *Genus Fagus.*
   - Common beech, Fagus sylvatica (L.)
   - Red beech, F. ferruginea (Ait.)
4. *Genus Corylus.*
   - Hazelnut, Corylus Americana (Walt.)
5. *Genus Ostrya.*
   - Hop hornbeam, or ironwood, Ostrya virginica (Willd.)

ORDER JUGLANDACEÆ—WALNUT.

1. *Genus Juglans.*
   White walnut, Juglans cinerea (L.)
   Black walnut, J. nigra (L.)
2. *Genus Carya.*
   Pig hickory, Carya glabra (Torr.)
   Shag hickory, C. alba (Nutt.)
   White hickory, C. microcarpa (Nutt.)
   Black hickory, C. tomenlosa (Nutt.)

ORDER CONIFERÆ—CONIFERS.

1. *Genus Pinus.*
   Pitch pine, Pinus rigida (Miller).
   Yellow pine, P. mitis (Mx.)
2. *Genus Abies.*
   Hemlock, Abies canadensis (Mx.)

ORDER ACERACEÆ—MAPLES.

1. *Genus Acer.*
   Red maple, Acer rubrum (L.)
   Var. trident, A. rubrum tridens.
   White maple, A. dasycarpum (Ehrh.)
   Sugar maple, A. saccharinum (L.)
   Black sugar maple, A. nigrum (Mx.)

ORDER MAGNOLICEÆ.

1. *Genus Magnolia* (magnoliads).
   Cucumber tree, Magnolia acuminata (L.)
   Umbrella tree, M. umbrella (Lam.)
   Ear-shaped magnolia, M. fraseri (Walt.)
2. *Genus Liriodendron.*
   Tulip tree (yellow poplar), Liriodendron tulipfera (L.)

ORDER OLEACEÆ—OLIVEWORTS.

1. *Genus Fraxinus.*
   Black ash, Fraxinus sambucifolia (Lam.)
   White ash, F. Americana (L.)
   Blue ash, F. quadrangulata (Mx.)

ORDER BETULACEÆ—BIRCHWORTS.

1. *Genus Betula.*
   Black birch, Betula lenta (L.)
   Yellow Birch, B. excelsa (Ait.)
   Red birch, B. nigra (Ait.)

ORDER ERICACEÆ—HEATHWORTS.

1. *Genus Kalmia.*
   American laurel, Kalmia latifolia (L.)
2. *Genus Oxydendrum.*
   Sourwood, Oxydendrum arboreum (D. C.)
3. *Genus Rhododendron.*
   Rose bay, Rhododendron maximum (L.)
4. *Genus Azalea.*
   Azalea, A. viscosa (L.)
5. *Genus Clethra.*
   Sweet pepper, Clethra acuminata (Mx.)

ORDER TILIACEÆ—LINDENBLOOMS.

1. *Genus Tilia.*
   Basswood, Tilia Americana (L.)
   White basswood, T. hetrophylla alba (Vent.)

ORDER ANACARDIACEÆ—SUMACHS.

1. *Genus Rhus.*
   Black sumach, Rhus glabra (L.)
   Mountain sumach, R. copallina (L.)

ORDER ROSACEÆ—ROSEWORTS.

1. *Genus Cerasus.*
   Black cherry, Cerasus serotina (D. C.)
2. *Genus Amelanchier.*
   Wild service or june-berry, Amelanchier canadensis (Torr. and Gr.)

ORDER LEGUMINOSA—LEGUMINOUS PLANTS.

1. *Genus Robinia.*
   Black locust, Robinia pseudacacia (L.)
2. *Genus Cercis.*
   Redbud or Judas tree, Cercis canadensis (L.)

ORDER HAMAMELACEÆ—HAZELWORTS.

1. *Genus Liquidamber.*
   Sweet gum, Liquidamber styraciflua (L.)
2. *Genus Hamamelis.*
   Witch hazel, Hamamelis Virginiana (L.)

ORDER AQUIFOLIACEÆ—HOLLYWORTS.

1. *Genus Ilex.*
   American holly, Ilex opaca (L.)

ORDER LAURACEÆ—LAURELS.

1. *Genus Benzoin.*
   Spicewood, Benzoin odoriferum (Nees.)

ORDER CORNACEÆ—CORNELS.

1. *Genus Cornus.*
   Dogwood, Cornus florida (L.)
   Green dogwood, Cornus alternifolia (L.)
2. *Genus Nyssa.*
   Black gum, Nyssa multiflora (Wang.)
   Swamp black gum, Nyssa uniflora (Walt.)

ORDER ARTOCARPACEÆ—ARTOCARPS.

1. *Genus Morus.*
   Mulberry, Morus rubra (L.)

ORDER PLATANACEÆ—SYCAMORES.

1. *Genus Platanus.*
   Sycamore, Platanus occidentalis (L.)

ORDER SAPINDACEÆ—INDIAN SOAPWORTS.

1. *Genus Æsculus.*
   Big buckeye, Æsculus flava (Ait.)
   Small buckeye, A. pavia (L.)

ORDER ANONACEÆ—ANONADS.

1. *Genus Asimina.*
   Papaw, Asimina triloba.

ORDER CAMELLIACEÆ.

1. *Genus Stuartia.*
   Stuartia, S. Virginica (Cav.)

ORDER CALYCANTHACEÆ—CALYCANTHS.

1. *Genus Calycanthus.*
   Sweet-scented shrub, Calycanthus floridus (L.)

GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT

ON THE

TIMBERS OF THE TRADEWATER REGION

CALDWELL, LYON, CRITTENDEN, HOPKINS, WEBSTER, AND UNION COUNTIES.

BY LAFAYETTE H. DEFRIESE.

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INTRODUCTORY LETTER.

NEW YORK, September 17, 1877.

Professor N. S. SHALER, *Director Kentucky Geological Survey:*

I submit herewith a report upon the timbers of the Tradewater River Region of Northwestern Kentucky. Owing to the favorable situation of this region, to its geological character and the minute but important changes in its surface soils and to the drain which has been made upon its timbers within the last few years, which is liable to increase rather than diminish in the future, I know of no part of Kentucky that furnishes a more interesting or important field for the study of some of the problems connected with the growth, decay, and succession of timbers. Such of these problems as my limited time and opportunity would permit me to consider, I have briefly discussed in the following pages.

I wish to acknowledge my indebtedness, and that of the Survey, to the Elizabethtown and Paducah Railroad for facilities of travel afforded, as well as to the many private individuals who, by their kindness, have helped to forward my labors.

Very respectfully yours,

LAFAYETTE H. DEFRIESE.

REPORT ON THE TIMBERS OF THE TRADEWATER REGION—CALDWELL, LYON, CRITTENDEN, HOPKINS, WEBSTER AND UNION COUNTIES.

GENERAL REMARKS.

I need say but little in regard to the method of timber study pursued in these counties, as it is almost identical with that described in a former report on the timbers of neighboring counties. In speaking of and tabulating the characteristics of the timbers of different localities, it will be noticed that I have changed my points of study to suit the changed conditions of the timbers. For instance, where there is a heavy drain constantly made upon the forests by cutting and floating out timbers, I have tried to find out about the rate at which valuable timbers are disappearing, and to compare that with the character and growth of the young forest trees, in order to arrive at the effects of such drain upon the future forests of Kentucky. Again, in another locality, where some other cause is operating to produce other effects, or where similar effects are produced by different means, I have paid especial attention to this changed condition of things and so on.

The valuable timbers in this part of Kentucky are chiefly the following, which are important in the order given: white oak, liriodendron (yellow poplar), white and black ash, white hickory (or second growth hickory of any variety), white elm, black walnut, post oak, sweet gum, bartram oak, and cotton tree. And when I say that these timbers are important in the order given, I take into consideration their value as a source of wealth to the State, which depends upon three things: the market value of the timber, the amount of it found in the

country and the use to which it is put. Of course, the market value of walnut is greater than that of any other timber in Kentucky, and, if that alone were considered, walnut would head the list of valuable timbers; but the comparatively small quantity of it now found in the country places it low in the scale. White oak must, therefore, be considered the most valuable timber of the Kentucky forests. In this part of Kentucky, it is the principal forest tree along all the streams, and on the more or less level, sandy soils. But, as a rule, in these counties it is not spread over the hills as in some parts of the State. On lands not more than twenty-five to forty-five feet above local drainage, and on loose sandy soils at almost any height above drainage, the white oak forms about 40 per cent. of the forest timbers. In hilly regions, however, the white oak usually gives way to black oak, scarlet oak, and post oak, at a height of about forty-five feet above local drainage. But not all of this white oak, scattered along the streams and through the woods of the interior part of the State, is available at present; nor is it likely to be for years to come. A large part of it must be looked upon merely as a reserve for the distant future, when the more convenient forests shall have been stripped of their white oak wealth by the enormous drains now made upon them. And in the following pages, unless the contrary is distinctly stated, I shall confine my discussion of the rate of disappearance of white oak timber from the forests to available white oak—that is, to white oak that is sufficiently convenient to some railroad, or to some stream large enough to float it out, to be procured without too great outlay. It should be kept in mind that the supply of this timber, which is too remote from present means of transportation to be considered here, inasmuch as there is no drain upon it and cannot be for years to come, is almost without limit. This possible reserve, however, should not be allowed to blind the people to the dangers that threaten the white oak in all places where it is exposed to heavy drains. For, after all, the expense of reaching timbers so distant from means of conveyance would cause a necessary resort to them to be almost as

great a calamity as the total disappearance of those timbers. Besides, whenever a resort to such timbers *does* become necessary, then the same rates of disappearance will apply to them which are now found to apply to those timbers subject to a present drain. For the present, therefore, I shall speak chiefly of available white oak, and from this point of view.

The valuable white oak timber of the Tradewater region is to be found within one or two miles of Tradewater river, on either side, and low down on the larger tributaries of that river, where the streams are of sufficient size to float out the logs. The same may be said of all the other timbers which I have given as the valuable ones, with the possible exception of the post oak, which grows abundantly along all the hill-tops. The question of immediate interest is, therefore, what is the *present* timber supply, and what the rate of consumption in these available localities? If the supply seem inexhaustible to one who rides hurriedly through miles and miles of massive white oak, sweet gum, hickories, etc., all the more impressive, if not alarming, is the truth which closer investigation forces upon him. Especially is this so of the white oak and liriodendron (yellow poplar). A careful calculation, extending along the whole available part of the Tradewater river and its tributaries, convinced me that about 30 per cent. of the valuable white oak, which forms so large a proportion of the forest timbers in these localities, has been cut out within recent years, while the young forest will furnish only about 5 per cent. of this timber to take its place. So that, since the drain upon the timber resources of the Tradewater region commenced, about 25 per cent. of the entire available white oak timber has disappeared. And even of that left standing, the timber found is larger and more valuable in proportion to its distance from a stream capable of floating it.

The effect of this drain upon the liriodendron (yellow poplar) is still more striking. In all the St. Louis limestone regions of Caldwell, Lyon, and Crittenden counties, along streams where yellow poplar ought to flourish, only now and then could a tree be found. When I inquired if it did not

grow in this region, I was invariably informed that there once was a great deal of poplar in these localities, but that it had all been cut out. The same is true, to an alarming extent, throughout the whole Tradewater country. High up on the Tradewater river, and on small and inconvenient tributaries, considerable quantities of liriodendron are to be found; but I know of no convenient locality in which any considerable body of really valuable yellow poplar timber now exists. It is perfectly safe to say that fifty per cent. of all the available timber of this kind has been cut out.

The sweet gum seems to be plenty, and the white elm more or less so; but it was impossible to form any idea of the future forests of these timbers. The drain upon them now, though considerable, is largely local. The black walnut is now mostly second growth, and seems to be small, rough, and limby. The reason is, I think, that it grows up only in open places, where it does not have to compete with other timbers. It is therefore confined to fence-rows and road-sides, where the ground is hard-trodden, or else to waste places where the soil is exceedingly poor. This gives it the character of a dwarf or scrub timber, which the old forest growth did not have.

DRAINS ON TIMBERS.

The principal drain upon timbers of the Tradewater region at present, outside of the local saw-mills to be found along all the streams where good timbers abound, is made by the spoke factory of Booth, Dulaney & Co., at Kuttawa, Lyon county. It is called a spoke factory, though in reality the firm manufacture, in addition to wagon and buggy spokes, hubs, felloes, axles, etc., nearly all modern implements used about the farm, such as axe-handles, broom-handles, ox-yokes, ox-bows, etc. A large part of the rived spoke timber (white oak) used by the factory is obtained from the Tradewater region. I was informed by a gentleman who has had many years of experience in that branch of business, that the best and most durable white oak timber in the United States comes from the Tradewater and its tributaries.

Probably the reason of this is, that the white oak which comes from too far south grows up rapidly, and, exposed to long summers and short winters, is too sappy for the best wagon timber, while, on the other hand, that obtained from too far north, owing to slow growth and exposure to long winters, is too brittle for long wear. This is merely a suggestion, however. At any rate, the timbers from this part of Kentucky are in great demand; and while I was in Kuttawa I met Mr. S. N. Brown, of Dayton, Ohio, who owns one of the largest hub and spoke factories in the West, who was then in Kentucky preparing timbers to ship to his factory.

Messrs. Booth, Dulaney & Co. use post oak altogether for heavy wagon hubs now, and say it outwears any other timber that can be used. Certainly their supply of that is unlimited. A hill variety of white elm is used for buggy hubs, and white hickory alone for buggy spokes and rims. White hickory is also used for wagon axles, double-trees, etc., and the white oak for spokes, bolsters, sawed felloes, etc. The firm employ one hundred men constantly, thirty of whom are engaged in cutting and floating logs, the products of which are shipped to nearly every State in the Union. They pay from $5 to $7 per thousand feet for logs rafted to them, or from $10 to $15 per acre for good timber lands. Except the white oak, they bring most of their timbers from up the Cumberland; but when one considers what an amount of white oak timber is here worked up into wagon materials monthly, he can easily see what an enormous drain is made upon a region whose available timbers are limited. Add to this the almost countless little saw-mills scattered along on every branch and creek in this whole region of country, which can easily shift from place to place as the timber is exhausted, and one can readily comprehend what a sweeping destruction of forest timbers is going on. Strangely enough, as yet the great factories of Paducah have not turned their attention toward the Tradewater as a convenient source of timber supply for them; but we may expect this as soon as the Cumberland and the Tennessee river timbers begin to be exhausted. When this time comes, should

it ever come, an additional drain of 6,000,000 feet of timber per year will be made upon the Tradewater country. It is needless to say that, with such an additional demand upon it, the valuable available timbers of this part of Kentucky would be exhausted in a few years. For I shall show, further on in this report, that there is little hope of a young forest which can take the place of the old one now passing away.

SPECIAL TIMBER VARIATIONS.

It should be noticed that in a former report* I spoke of a peculiar, and, in many respects, remarkable belt of timbers crossing the Hartford and Cloverport road, about twelve miles from Cloverport, and running a slightly varying east and west course across Breckinridge and Ohio counties. The ground is high and nearly level, and the soil a loose, damp, sandy formation. The belt is about five miles wide. In passing down the Tradewater I found a timber belt, which, from its width, the formation of the soil, and the character of the timbers, I believe to be a continuation of the belt formerly spoken of. It is about six miles wide and crosses Hopkins county between Garnettsville (now Dalton) and Providence. In this strip of woods the white oak, liriodendron (yellow poplar), white and blue ash, white hickory, black walnut (most of which has been cut out), are unsurpassed in size and beauty. They form a marked contrast to the timbers on either side of the belt. If these two belts be the same, as I believe them to be from similarity of characteristics, we have the remarkable phenomenon of a belt of the finest timbers extending, so far as observed, for more than one hundred miles, through other forests where the timbers are good, but not extraordinary, and following the general course of the Ohio river, though at no point, so far as I know, nearer to the river than ten miles. The belt is certainly not a level-topped, sandy range of hills bordering the Ohio, for there are numerous hills and hollows between it and the Ohio, on none of which is the timber especially noticeable.

*See page 65.

But there is one difference between this timber belt east of Green river, and the same (if it be the same) west of that river, which deserves especial attention: that is, the belt east of Green river is remarkable for its massive chestnut timber, often more than five feet in diameter, which forms a large per centage of the forest trees. West of Green river, however, I was not able to find a single chestnut in all the counties passed through, and all those of whom I inquired said that they had never seen a chestnut on the west side of Green river in that part of Kentucky. Certainly this is remarkable. The geological formation on the opposite sides of Green river is exactly the same, so far as I could determine, and is, so far as the surface is concerned, mostly the sandstone of the coal measure group. The regular pebbly conglomerate seldom appears here, even on the hill-tops. Certainly, in the belts spoken of, I could detect no difference whatever. Both (if they be two, and not, as I think, the same) are high, level, or nearly so, damp and sandy, and the massive timbers of the two are exactly the same, with the exception of the chestnut. If it be true, as I was informed (and it certainly is, as far as I was able to investigate), that no chestnut is found in this part of Kentucky, west of Green river, the reason why the chestnut should jut up against this river, and find in it a perfect barrier to its westward course, is worthy of investigation. With the limited time for study at my command, I could discover no cause for such a phenomenon.

While speaking of timber variation, I wish to notice the question of the succession of forests in Kentucky and to mention the results of some observations made by me in that direction.

In the report before referred to (vol. II, this series), I gave my reason for believing that the present forests of white oak will be supplanted, in the future, by black oak, red oak, Spanish oak, and such timbers, of which black oak will be the leading timber. Two questions present themselves to me in this connection for solution: 1. Is it merely the white oak that is supplanted by the black oak, while of other timbers each will

be succeeded by one differing from itself, but not necessarily black oak; or is black oak taking the place of all timbers alike? In other words, will the future forests of Kentucky consist of about the same timbers as the present forests, except that each timber will appear in the place of some other, and in a different locality, or will some one timber supplant all alike, and be the leading forest tree of Kentucky in the future? 2. In case it should be found that no regular rotation of forests is taking place, but that some one timber is supplanting all others, in what way can the present distribution of timbers be best secured?

In reference to the first question, I noticed that in all those localities along the Tradewater, if the immediate borders of the streams be excepted, where the white oak forests are now finest, but where the present timbers are fast disappearing on account of the drain constantly made upon them, that the undergrowth has about the same per centage of black oak that the present forest has of white oak—on an average about 40 per cent. Very little white oak, indeed, will appear in the future forest, even in regions where now it most appears. I then noticed carefully localities where the present predominant timber is black oak, red oak, post oak, or hickory, and in each case I found that the undergrowth contained from 25 to 40 per cent. of black oak, while no white oak at all appeared. It seems to be an inevitable conclusion, therefore, that the present valuable timbers of Kentucky are disappearing, and that the comparatively worthless black oak is to be the universally predominant tree of the future. This is not true of the hickory, of which there will be as large per centage in the future as there is in the present forests; while of white elm and white ash, on account of the comparatively small proportion of these timbers, except in somewhat low lands, I found it impossible to obtain data enough to warrant a conclusion. My opinion is, that they, too, will almost disappear when those in the present forest are removed or die down. Of the swamp timbers proper, such as sweet gum, sycamore, red elm, maple, etc., I see no reason to expect a change; but of the white oak

and liriodendron (yellow poplar), which, after all, are the great staple timbers of Kentucky, I believe the time will come, and that far sooner than those who have not investigated the subject suspect, when they will disappear entirely from our forests, unless some earnest effort is made to avoid such a calamity.

The second question then presents itself, viz: How can the present variety and distribution of Kentucky timbers be maintained? I have two methods to suggest, neither of which will, I fear, be acted upon until the people become alarmed at the condition of their forests, and show more energy in caring for and perpetuating them than they have shown in the past. One of these methods is to plant trees of the same kind as rapidly as the old timbers are cut away, or as the land is exhausted and "turned out," and to keep down other growths until the planted trees get a start. This needs no discussion. It is the method that *must* be adopted in introducing a new variety of timber into a forest, as well as in perpetuating some varieties. I believe that the black walnut, for instance, can be preserved only in this way.

The second method, which can be employed only where, as is the case to a large extent in Kentucky, the present forest is the kind desired, is perhaps the more available of the two. It is well known to all observers of timber growth, that if a tree be cut down toward the spring of the year, just before the sap begins to rise, a large number of shoots or "sprouts" will spring from the stump of the fallen tree. If those who are cutting timber to float out would cut as late in the winter as possible consistently with meeting the spring freshets, the sap rising in the stumps of the lately cut trees would cause this growth of shoots. Then if the undergrowth of the different varieties, which already have such a start as to soon smother the tender bushes springing from the stumps of the fallen trees, were merely cut away, these bushes would get such a start as to hold their ground, and the present forest timbers would be preserved in about their present proportions. This would really require very little labor; and, while I have never seen the experiment tried on a large scale, I believe it

would be entirely successful. Certainly, if the present forests of Kentucky can be preserved by so small an outlay of thought and labor now, it is of the highest importance to the people to see that this source of wealth to the State is not allowed to waste away. Otherwise, their descendants of a few generations hence will be compelled to go through the slow and laborious process of planting and cultivating those very timbers which are so abundant to-day, and which, by a little care on the part of their forefathers, might have been left to them as a rich inheritance.

SOME EFFECTS OF TIMBER CLEARING.

It is a lamentable practice in most farming regions of Kentucky, when a piece of ground becomes somewhat exhausted, to clear another piece and tear down the fence of the former to inclose the latter, leaving the worn-out lands exposed to the ravages of stock, in addition to washing rains. The consequence is, that cattle eat down each little bush or weed, on the lands thus suddenly exposed, as fast as it appears. As the soil has been lately cultivated, and is comparatively loose, a few heavy rains start myriads of "gullies" in the ground, whose only protection against such washes was removed by "turning the land out," and allowing the cattle to eat down the little herbage and bushes that might otherwise have cemented the surface soil. A few years of such exposure gives the "washes" such a start that no amount of care and labor can preserve the land from utter destruction. If one reflects upon how many farmers there are in Kentucky, and that the vicious system of culture pursued by them consists, in the greater part of the State, in thus clearing a piece of land, working it without manure or much rotation of crops, year after year, until exhausted, a process which, on an average, requires only five or six years, when they abandon it and clear new ground, one can realize how many acres of the land of Kentucky are thus annually "turned out." Aside from the destruction of valuable forests entailed by such a system of cultivation, the effects upon the soil and climate of the regions thus cleared are very

serious. Granted that in the course of years other forests will spring up in such districts, I have elsewhere shown that these new forests will be comparatively valueless, so far as the timbers are concerned. Of course, their presence would prevent the further washing of the soil and change of climate produced by barrenness, but nothing more. In fact, however, I see little hope of a worn-out soil thus exposed ever reclothing itself with timbers of any kind. Timber growth upon such exhausted soils is so slow that its battle with washing rains would be doubtful, even with the best protection that could be given it; but when to the washing of rains is also added the ravages and trampling of cattle, and other such things incident to a totally exposed piece of once cultivated soil, I believe that the chances of a new forest growth are exceedingly poor. I have myself seen a piece of exhausted land that had stood thus, as I was informed, for twenty years. In it I measured washes fourteen feet deep and twelve feet wide, while almost every square yard was crossed by a "rut" or "gully" of greater or less size. A few scraggy persimmon bushes occupied the still unwashed spots; but it seemed to me inevitable that the entire two hundred acres of once fertile ground would soon have its surface soil completely washed away. If the farming lands of Kentucky were level prairie lands, the facts here spoken of would not be so serious; but, on the contrary, the ground is hilly or rolling, and the effects of reckless destruction of forests on such lands are always fatal. I have not seen these effects better stated than in the London Spectator of June 16, 1877, which says:

"The evidence that the great floods which have from time to time, during the last half century, been so destructive in Switzerland, and in many districts of France and Italy, have been mainly caused by the felling of the forests on the high grounds, appears to be overwhelming. In the department of the Loire especially, it was universally remarked, that the wooded grounds suffered no change, while in the denuded districts, the whole soil of cleared and cultivated fields was swept away, and the rocks laid bare. The same was seen in

the upper Rhine in 1868. The clearings in the province of the Ardeche have produced the most melancholy results within the last thirty years, one third of its area having become barren; and new torrents had, in 1842, destroyed 70,000 acres of land, an evil which has been going on ever since that time. The denudation of the crests of the Vosges has done infinite harm in Alsace. Many places in Provence, rich and inhabited half a century ago, have become deserts. Thousands of torrents have been formed within the last dozen years on the southern flank of the Piedmontese Alps and in Dauphiny, and grassy slopes have been converted into stony chasms by the cutting of the woods above. In the department of the lower Alps, between 1842 and 1852, 61,000 acres went out of cultivation from this cause. In Italy, the demand for Italian iron during the wars of Napoleon I, the trade with England being cut off, necessitated vast cuttings of wood for fuel, and the effects are felt to this day, especially in the valley of the Po. In fact, there is scarcely a country on the continent of Europe in which the reckless destruction of forest has not been admitted, both in popular belief and by the verdict of science, to have been the cause of misery, of the amount of which the majority even of well-informed persons in England have little conception."

Change the names in this article to those of the hills and mountains of Kentucky, and the process now going on in our State will be startlingly described.

Another result of the reckless clearing up of forests and destruction of timbers is the effect produced upon the climate. I shall have little to say upon this subject, for it lies without the proper sphere of my inquiry. It is a fact, thoroughly proved by experience, that in the far West, as civilization pushes itself backward, clearing up the forests as it goes, the change in climate brought about in a few years is very marked. The winters grow bleaker and colder, the springs later, and the summers drier and more subject to alternations of violent storms and long droughts. The reason for this I believe to be as follows: Heavy forests produce two effects upon cli-

mate in winter—they break the cold, bleak winds that sweep over the country, and give it protection in that way; and they add actual warmth to it from what I believe to be the fact, that the temperature of a living tree never falls quite so low as that of the surrounding atmosphere in exceedingly cold weather. Let the difference be ever so slight, where a country is thickly studded with trees, each one a very little warmer than the atmosphere about it, the effect of the whole upon the climate will be very appreciable. In summer, too, where millions of trees are drawing up water from their deeply-set roots to be evaporated from the leaves, the atmosphere must always be more moist and pure than it would be were it to receive no such water supply to give back in dews at night. This moisture prevents, to some extent, the long droughts to which a country without forests is subject, and, added to the purity of an air washed in fresh dews nightly, tends to prevent the violent storms of wind and lightning which result from a long heated and impure atmosphere. I am well aware that Mr. Meehan, and others equally profound and scholarly, argue that "forests are the result, not the causes of climate," and I am also aware that there are many obvious facts which point, in a certain degree, to that conclusion. Thus, for instance, one might mention the difference between a tropical forest and that of a temperate or frigid climate, or even point to the difference between timbers at different heights, and therefore different temperatures, on the same mountain. Such arguments, however, only go to show that certain timbers are best adapted to certain climates, and that originally there would be no forest at all on a piece of ground not naturally adapted to a forest growth, or that whatever forest did appear, would be the one best adapted to the soil, temperature, and other conditions of growth. But they by no means show, or tend to show, that a given wide range of country would be exactly the same, so far as climate is concerned, whether it were barren or covered with heavy forests. This subject, in its details, however, even were it properly a part of my discussion, is too complicated for further notice, and demands more investiga-

tion than I could give to it. A course of long and careful inquiry in this direction, by some able meteorologist and botanist, would be of almost incalculable benefit.

TIMBER IN DETAIL.

I shall now proceed to give in detail an account of the timbers to be found in the counties under discussion, and their local variations. In the immediate vicinity of Princeton the principal timbers noted were bartram oak, white ash, red oak, black oak, swamp white oak, sugar-tree (black), black hickory, white hickory, and liriodendron (yellow poplar). Bartram oak is seldom found, except in low, damp soils, or along streams; but near Princeton considerable quantities appear in a flat woodland quite high and dry. A large per centage of white ash also appears in the same woodland, which lies about one mile from Princeton. With the exception of this woodland, the timbers are mostly cleared away for two or three miles around. The formation is Sub-carboniferous limestone, of Chester Group on high ground, and of St. Louis limestone on low grounds.

In going toward Eddyville, the principal swamp or lowland timbers are, in addition to those given above, yellow birch, pin oak, sweet gum, white and red elm, sycamore, black walnut, and such small growth as flowering dogwood, pith elder, redbud (in small quantities), etc. These alternate with the hill timbers, which are white oak, black oak, scarlet oak, black hickory (scrub), post oak, etc., with some laurel oak, on both low and high grounds, though in the latter case it is always along fence-rows. There is probably 20 or 25 per cent. of white oak among the forest timbers here; but among the bushes and young trees little or no white oak is to be found. The timbers remain essentially the same in all the region of country between Princeton, Eddyville, and Milleville, the swamp timbers being quite good along South Fork and the other small streams in the neighborhood. There is little present drain upon the forests through here, except where the timbers are cut for local saw-mills.

About six miles from Princeton, and not far from the junction of the Hopkinsville and Parkersville roads, a very large spring gushes out from the base of a reddish limestone bluff. Scattered all over this bluff are cedars of various sizes, which I mention as a matter of curiosity rather than of value, as in no other place in this part of Western Kentucky have I seen a member of the coniferous order. A few water poplars (cotton trees) appear along the streams between Princeton and Eddyville, but they are scattering. On the southern slopes of the low hills near Eddyville the white oak is quite good, but not remarkable. Along the Cumberland river, in addition to the timbers already given, hackberry, shag hickory, and honey locust appear. There is quite a marked change in the timbers on the long slopes facing the Cumberland river, near Eddyville. They become very heavy and fine, though the most valuable of them have been cut out. The reason of such change is, that we here pass from the loose rocky or poor shaly limestone of the Chester Group, which is found all along the high ridge road for two or three miles, until the cavernous St. Louis limestone bordering the river is reached.

Another peculiarity noticed in the report in volume II, this series, observation all through this Sub-carboniferous formation confirmed: that is, that the liriodendron (yellow poplar) does not grow on the upper or shaly Chester. If found there at all, it is very scattering, as well as dwarfed, and of no value. The dryness and thinness of the upper Chester soil is doubtless the cause of its absence.

After leaving Eddyville and turning toward Dycusburg, one passes from the St. Louis limestone into the thin Chester of the ridges again. Liriodendron almost wholly disappears, except on streams, and but little white oak is found for some miles. Bartram oak, some hackberry, white walnut (so characteristic of the Ohio river regions), sycamore, white and red elm, etc., are found along the streams; but the forests are not very valuable between Eddyville and Dycusburg. From this statement we may except the post oak, which forms 40 per cent. of the ridge timbers, and which is now used in making hubs

for heavy wagons. But I noticed that on these ridges the undergrowth was largely black oak and scarlet oak, which seem to be replacing even the post oak. On the limestone formation along Livingston creek there has once been a considerable amount of liriodendron timber; but that has been cut away, so that scarcely any is now to be found.

In going from Dycusburg back toward the head waters of the Tradewater river, there are some very fine bodies of timber, especially white oak and liriodendron. Along all the small streams and on low grounds, as well as on high grounds in some localities, these timbers are found in great abundance, forming together about 50 per cent. of the forest trees, and are massive and valuable. The liriodendron timber here spoken of, though, does not appear until the cavernous St. Louis limestone, within about four miles of Fredonia, is reached; but from this place to Fredonia there is little variation in size, value, or quality of the timbers. They consist of white oak, black and shag hickory, liriodendron, Spanish oak, black oak, and red oak, with bartram oak, white and red elm, beeches, sugar maple, black gum, sweet gum, and small quantities of honey locust and black walnut at a less height above water level. These timbers remain essentially the same for about three miles beyond Fredonia toward Dalton (formerly Garnettsville), where we pass from the limestone to a coarse, reddish, Sub-carboniferous sandstone, the country becomes quite hilly and broken, and the timbers grow more or less strongly marked into upland and lowland timbers, the two alternating with reference to height above drainage. Even on Sinking Fork of Livingston creek, four miles from Fredonia, no limestone is found. The timbers are the usual swamp ones—swamp white oak, white oak, pig and shag hickory, red and white elm, bartram oak, some white ash, etc. These become very fine about six miles from Fredonia, all along the foot-hills, while the ridges furnish post oak, black oak, scarlet oak, black hickory, and other timbers more or less scrubby. The forest, after leaving Fredonia, cannot be considered very valuable until Donaldson creek is reached,

fully ten miles from Fredonia. There are local spots of valuable timbers, but they are in a hilly, out-of-the-way part of the country, and are not available. The Donaldson creek region cannot be said to be convenient of access, but probably before many years the branches that form its head waters will be penetrated for the old forest walnut that is still scattered along them. These walnut trees vary from twenty to forty inches in diameter—one I noted measuring five feet in diameter, with a straight trunk of sixty feet. But they are largely cut away, even now, to supply local demand. The white oak and less valuable timbers need scarcely be taken into consideration in this locality, as no exigency of the near future is likely to compel a resort to resources so remote from means of transportation. It is enough to say, that along all the streams and branches which go to make up the head waters of Tradewater river white oak, bartram oak, liriodendron (yellow poplar), white and black ash, shag and pig hickory, with more or less white hickory, black walnut, red and white elm, and sweet gum, are found, most of them in great abundance and of the finest kind in size and quality. The hills are covered with post oak, black oak, Spanish oak, and the usual hill timbers.

After turning down Tradewater river from Dalton (erroneously marked on the preliminary map "Chalk Level"), not a great deal need be said in a cursory view of the timbers. The sectional tables, which commence on page 23, will have to be relied upon largely for an accurate knowledge of the nature and distribution of the timbers. The rate at which the forests are now cut away could not be exhibited accurately in tables, but that has already been noticed; so I shall do no more here than to note briefly special points of interest connected with the timbers on the Tradewater river between Dalton and the Ohio.

On Lick creek, a few miles above Dalton, among the finest sweet gums found in Kentucky are noted, varying from two and one half feet to four feet in diameter; shag hickory from three feet to three and one half feet in diameter, white oak three and one half feet, and liriodendron four feet, are also

found in great abundance. The formation is a wide and marshy swamp in the coal measures. Black walnut is scarce, and pin oak is large and noticeable immediately on the creek. After crossing Lick creek one enters the splendid "belt" of timbers elsewhere noticed. The ground is high, level, sandy, and moist. The liriodendron and white oak are unsurpassed, and the white, shag, and pig hickories and white ash are of the finest. Bartram oak, which usually grows on low or moist grounds, flourishes. The undergrowth is composed principally of hickory and black oak, of which about equal proportions exist. I have only noticed one other location in Kentucky, of any considerable extent, where the black oak has a rival for the first place among the undergrowth.

On Clear creek a great deal of swamp laurel oak is found, often twenty-six inches in diameter. Near Providence the fine "belt" timber gives out again, one passes from the high, level, sandy soil onto a rolling formation, whose foot-hill timbers are largely white oak, which gives way to post oak, black oak, scarlet oak, and black hickory toward the hill-tops. But little change is noted in the timbers until Crab Orchard creek is crossed. Then one traverses a flat, white, sandy level, where Spanish oak, red oak, post oak, and black hickory form the entire forest. The belt is narrow, and the normal timbers are met with after crossing it. It is worth notice that the western cottonwood is found on Crab Orchard creek, where also the white ash is very fine.

After crossing Crab Orchard creek the road is almost imperceptibly ascending, and one soon reaches the top of a high, level ridge, varying from one to three miles in width, which forms a water-shed that lasts nearly to the Ohio river, with one or two streams cutting across it between Crab Orchard creek and the Ohio. Along the foot-hill exposure of this ridge toward Tradewater the white oak, liriodendron (where it is not cut away), white ash, sweet gum, and other valuable timbers abound. Along the road itself, owing to the naturally high position above drainage, a change of level of a few feet is sufficient to make the white oak give way to post oak and

black oak, or *vice versa*. The white oak is found only in little depressions along the road. After reaching the high hills and deep hollows, upon nearing the Ohio river, the same change of timber with the height above drainage takes place, the only difference being that it takes a much greater change of level to produce a corresponding change in the timbers.

TIMBER TABLES.

The following tables are given consecutively in the order in which they were taken. The area represented by a table varies from twenty-five hundred square yards to five thousand square yards, more or less.

I call a tree decayed where large and prominent branches are dead, or where the body of the tree is not sound, or where it shows general evidences of unsoundness.

Name.	Number.	Average diameter.	Number dead.	Number decayed.
Bartram oak	4	26 inches.	1	1
Red oak	4	23 "	0	1
Black oak	2	26 "	0	1
Swamp white oak	2	18 "	0	0
White ash	7	20–28 "	1	1
Sugar maple	2	24 "	0	0
White hickory	2	16 "	0	0
Black hickory	1	26 "	0	0

Location, flat woods near Princeton; formation, St. Louis limestone; undergrowth very scarce.

Name.	Number.	Average diameter.	Dead.	Decayed.
Sugar tree	15	20 inches.	1	3
Scarlet oak	5	19 "	0	1
White hickory	3	small.	0	0
White elm	3	18 "	0	1
Black walnut	3	1–20 "	0	1
Redbud	1	14 "	0	1
Sycamore	3	small.	0	0

Location, a creek swamp four miles from Princeton. Liriodendron trees are in the vicinity, though not in the section.

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
Black oak	17	18 inches.	4	0	2
Scarlet oak	2	17 "	0	0	0
Black jack	6	14 "	0	0	1
Post oak	4	16 "	0	0	1
Black hickory . . .	2	14 "	0	0	0

Among the smaller timbers are black gum, flowering dogwood, and pig hickory, with a great deal of upland laurel oak in spots. White oak does not appear in the locality. Location high, level, limestone formation, about seven and one half miles from Eddyville. Cut timber means timber more or less freshly cut; otherwise it would be impossible to classify it.

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
White oak	25	23 inches.	8	1	3
Red oak	2	20 "	0	0	0
Black oak	1	18 "	0	0	1
Liriodendron (poplar)	4	18 "	2	0	0
Pig hickory	2	20 "	0	0	0

Dogwood, sassafras, black gum, etc., are small growths. Among the undergrowth black oak and white oak are in the proportion of two to one; while in the old growth it will be noticed their proportion is one to twenty-five. Location, a hill sloping 6° south, situated about five miles from Eddyville.

Name.	Number.	Average diameter.
Black oak	22	16 inches.
Spanish oak.	16	12 "
Scarlet oak	7	10 "
Post oak	2	
White oak	1	

Location, about four and one half miles from Eddyville, on Dycusburg road. The forest out so far is nearly altogether second growth, and the character of the timbers is worthy of

notice, as indicating the nature of the forest that will succeed the one now passing away.

Name.	Number.	Average diameter.	Dead.	Decayed.
Post oak	14	17 inches.	0	3
Black oak	6	16 "	1	1
Scarlet oak	7	14 "	0	2
White oak	1	16 "	0	1
Pig hickory.	1	14 "	0	0
Black hickory.	2	13 "	0	1

Location, a long-rolling, upper Chester formation, about three miles from Dycusburg. Absence of liriodendron (yellow poplar) on the upper Chester is to be noted.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	14	28 inches.	2	3
Post oak	2	18 "	0	1
Black hickory.	5	20 "	0	1
Pig hickory.	1	18 "	0	0
Liriodendron (poplar)	1	28 "	0	0

White elm, black gum, sassafras, etc., are small growth. Black oak forms 50 per cent. of the undergrowth, although it does not appear in the old growth. Location, a foot-hill about three miles from Dycusburg, on the Fredonia road.

Name.	Number	Average diameter.	Dead.	Decayed.
White oak	15	32 inches.	1	2
Liriodendron (poplar)	9	38 "	0	2
Black oak	3	30 "	0	1
Shag hickory	1	28 "	0	0
Pig hickory.	3	26 "	0	0
White ash	1	28 "	0	0

Location, three miles from Fredonia; formation, cavernous, St. Louis limestone, overlaid by a reddish clay. Land very rich. Timber remains heavy on to Fredonia.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	13	18–30 inches	0	3
Spanish oak	5	20 "	0	2
Black oak	1	18 "	0	0
Liriodendron (poplar)	2	20 "	0	0
Shag hickory	1	16 "	0	0
Black locust	1	20 "	0	0

Black gum, dogwood, mulberry, and sycamore form the less important timbers.

Location, a foot-hill about three miles from Fredonia, on Dalton road, near a small branch, which forms the dividing line between the limestone and a Sub-carboniferous sandstone. All through to Donaldson creek the timbers are heavy and fine, and a large proportion of white ash is found.

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
White oak	17	36–50 inches	6	0	2
Red oak	2	26 "	1	0	0
Liriodendron	5	30 "	2	0	1
White ash	4	18 "	0	0	1
Black hickory	4	20 "	2	0	0
Pig hickory	1	22 "	0	0	0
Sugar-tree	1	20 "	0	0	0

Black walnut, black oak, and white elm are found in the locality. Formation, the sandstone of the coal measures. Location, hill slope, south exposure, just after crossing Lick creek, and on the border of the "belt" of fine timbers spoken of elsewhere.

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
White oak	8	26 inches.	1	0	2
Black oak	3	20 "	0	0	0
Pig hickory	6	18 "	1	0	0

Liriodendron is found in the locality, though all the timbers here are below the average in the country. Location, near Providence, after crossing the "belt" of fine timbers.

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
White oak	22	23 inches.	6	0	1
Red oak	1	21 "	0	0	0
Pig hickory	6	22 "	0	2	1
Shag hickory	2	21 "	0	0	0
Black gum	4	14 "	0	0	0

Among the undergrowth black oak and white oak are found in the proportion of six to five; but this comparatively large per centage of white oak in the undergrowth is local. Location, a foot-hill about eight miles from Providence.

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
White oak	13	28 inches.	5	0	2
Spanish oak	7	23 "	0	0	2
Black oak	1	20 "	0	0	0
Liriodendron	9	21 "	4	0	0
Shag hickory	3	22 "	0	0	1
Pig hickory	2	21 "	0	0	0
White elm	2	18 "	0	0	0
White ash	2	23 "	0	0	1

This is a section of a foot-hill about twelve miles from Caseyville; the following is a section about midway up the same hill, and the last is a section on the hill-top. The three are given to show the gradations of the timbers according to height above drainage:

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
Black oak	12	19 inches.	0	0	2
White oak	3	20 "	0	0	0
Spanish oak	5	20 "	0	0	1
Post oak	4	18 "	0	0	1
Black hickory	3	20 "	0	0	0
Pig hickory	1	19 "	0	0	0

Name.	Number.	Average diameter.	Cut.	Dead.	Decayed.
Post oak	15	16 inches.	0	0	4
Black oak	5	17 "	0	0	2
Black hickory	3	15 "	0	0	0

The gradation of white oak into black oak, and black oak into post oak, as leading timbers at different heights above drainage, is well marked. Of the young growth, black oak is the leading timber in all three positions. The hill here given is a good representative of the timbers between this point and the Ohio river.

The numbers given in the foregoing tables include the numbers *cut* also, so that the proportions of sound, decayed, cut and uncut timbers, can be readily seen. Of course, no generalizations from these tables could be relied upon as perfectly accurate; for it is impossible, even with the utmost care, to choose a plot of ground whose timbers are perfectly representative of the locality. Still, the tables were prepared very carefully, and any generalizations made from them can be relied upon as accurate enough for ordinary purposes. By a small amount of computation, a great deal of interesting and important information can be gained from them. I give below a table which shows, at a glance, some of the most important inferences to be drawn from the preceding tables:

Name.	Per cent. uncut.	Per cent. cut.	Per cent. dead.	Per cent. decayed.
White oak	70+	30 nearly.	1.1+	8 +
Liriodendron (poplar)	70	30	Less than one.	10
White ash	99 nearly.	1 +	7 +	14 +
Hickories	94.6 "	5.4+	3.6+	7.2+
Post oak	100 "	Less than one.	Less than one.	24.4 nearly.
Black oak	94.4+	5.5+	1.4 nearly.	14 "
Red oak	88 +	11 +	Less than one.	11 +
Spanish oak	100 "	Less than one.	Less than one.	18.2
Scarlet oak	100 "	Less than one.	Less than one.	14 +

From this table we learn that, so far, at least, as this part of Kentucky is concerned, the hickories are the soundest timbers, and next to them ranks the white oak, while the post oak furnishes the largest per centage of unsound timber. I suspect the reason for this to be, that the post oak is a hill growth almost entirely, and among all timbers there are more decayed branches and unhealthy trunks on high ground than on low ground. This view is partially sustained by the fact,

that although so large a per centage of the post oak timber is decayed, a smaller proportion of it is actually dead than of either hickory or white oak—the two soundest timbers. Few would expect to find the white ash furnishing the largest per centage of dead timbers, but such is the fact. The comparative scarcity of the white ash conceals the relatively large proportion of it that is dying. The most important fact to be noticed in this table, however, is the large amount of white oak and liriodendron that has been cut away within a few years. The loss of thirty per cent. of these two valuable timbers within so short a time, taken in connection with the fact previously noticed, that other timbers are supplanting them as fast as they are destroyed, is alarming. I deem it sufficient merely to call attention to the present rate of loss of the white oak and liriodendron. Any one can realize the calamity which would ensue were they lost altogether to the Kentucky forests.

SUMMARY.

The results of a careful study of the timbers in the counties under discussion may be summarized as follows:

1. The valuable walnut has been, to a great extent, cut out, but some is still found along the heads of the streams that help to form the upper Tradewater river, as well as high up on most streams that flow into it.

2. White oak is found all along the streams and branches of this part of Kentucky, as well as along the foot-hills and on low grounds generally. In many localities, even the hill-tops are covered with it; but, generally speaking, it does not extend high up the hill-sides. The best of that in the immediate vicinity of Tradewater river has been cut and floated out, and the present drain upon the timber is directly proportional to its convenience for transportation. That which is available without much expense will, at the present rate of demand, be exhausted in the not distant future.

3. The ash is not very plenty, and is scattered generally through the forest on rich spots of ground. There is a

good deal of white ash, but it is widely scattered and does not seem so plenty as it really is.

4. The liriodendron, which is so valuable a timber tree, has largely disappeared from the neighborhood of streams capable of floating it out. Even on the smallest streams, local mills are using it up rapidly. I was informed that the forests were once full of it, where now scarcely a tree is to be seen for miles. Great apprehension is to be felt of a want of this timber even in the near future.

5. White elm is found along all the tributaries of the Tradewater, and is tolerably plenty. I had no means of determining its probable proportion in the future forests.

6. Post oak is plenty, covering all the hills through this part of Kentucky, and extending far down toward the foot-hills. There is no need to fear a dearth of it for years to come, though it does not seem to hold its own in the coming forests.

7. No chestnut is to be found in this part of Kentucky. As it exists in great plenty in other parts of the State, on exactly similar geological formations, I could see no reason for its absence.

Complete List of Timbers Found.

ORDER CUPULIFERÆ—MASTWORTS.

1. *Genus Quercus.*
   - White oak, Quercus alba (L.)
   - Red oak, Q. rubra (L.)
   - Pin oak, Q. palustris (Mx.)
   - Spanish oak, Q. falcata (L.)
   - Black oak, Q. tinctoria (Bart.)
   - Post oak, Q. obtusiloba (Mx.)
   - Black jack, Q. nigra (L.)
   - Chestnut oak, Q. castanea (Muhl.)
   - Scarlet oak, Q. coccinea (Wang.)
   - Bartram oak, Q. heterophylla (Mx.)
   - Swamp white oak, Q. bicolor (Willd.)
   - Laurel oak, Q. imbricaria (Mx.)
   - Swamp laurel oak, Q. laurifolia (Mx.)

2. *Genus Fagus.*
   - Common beech, Fagus sylvatica (L.)
   - Red beech, F. ferruginea (Ait.)
3. *Genus Ostrya.*
   - Hop hornbeam or ironwood, Ostrya virginica (Willd.)

ORDER JUGLANDACEÆ—WALNUT.

1. *Genus Juglans.*
   - White walnut, Juglans cinerea (L.)
   - Black walnut, J. nigra (L.)
2. *Genus Carya.*
   - Shagbark hickory, Carya alba (Nutt.)
   - Mockernut, C. tomentosa (Nutt.)
   - Pignut hickory, C. glabra (Sorr.)
   - White hickory, C. microcarpa (Nutt.)

ORDER SILICACEÆ—WILLOWWORTS.

1. *Genus Salix.*
   - Basket osier, Salix riminalis (L.)
   - Green osier, S. petiolaris (Smith.)
2. *Genus Populus.*
   - Cotton tree, Populus angulata (Ait.)
   - Silver-leaf poplar, P. alba (L.)
   - Balm of gilead, P. candicans (Ait.)

ORDER ACERACEÆ.

1. *Genus Acer.*
   - Red maple, Acer rubrum.
   - White maple, A. dasycarpum (Ehrh.)
   - Sugar maple, A. saccharinum (L.)
   - Black sugar maple, A. nigrum (Mx.)
2. *Genus Negundo.*
   - Box elder, Negundo aceroides (Moench.)

ORDER ULMACEÆ—ELMWORTS.

1. *Genus Ulmus.*
   - Red elm (slippery elm), Ulmus fulva (L.)
   - White elm, U. americana (L.)
   - Winged elm (Whahoo), U. alata (Mx.)
2. *Genus Celtis.*
   - Hackberry, Celtis occidentalis (L.)

ORDER CORNACEÆ.

1. *Genus Cornus.*
   Flowering dogwood, Cornus florida (L.)
   Low cornel, C. Canadensis (L.)
2. *Genus Nyssa.*
   Black gum, Nyssa multiflora (Wang.)
   Swamp black gum, N. uniflora (Walt.)

ORDER BETULACEÆ—BIRCHWORTS.

1. *Genus Betula.*
   Red birch, Betula nigra (Ait.)
   Yellow birch, B. excelsa (Ait.)
2. *Genus Alnus.*
   Smooth alder, Alnus serrulata (Willd.)

ORDER ROSACEÆ.

1. *Genus Cerasus.*
   Black cherry, Cerasus serotina (D. C.)
   Red cherry, C. pennsylvanica (Ait.)
2. *Genus Cratægus.*
   Hawthorn, Cratægus oxycantha (L.)

ORDER LEGUMINOSÆ.

1. *Genus Gleditschia.*
   Honey locust, Gleditschia triacanthus (L.)
2. *Genus Robinia.*
   Black locust, Robinia pseudacacia (L.)
3. *Genus Cercis.*
   Redbud (Judas tree), Cercis Canadensis (L.)

ORDER OLEACEÆ—OLIVEWORTS.

1. *Genus Fraxinus.*
   White ash, Fraxinus Americana (L.)
   Blue ash, F. quadrangulata (Mx.)
   Black ash, F. sambucifolia (Lam.)

ORDER CAPRIFOLIACEÆ.

1. *Geuus Sambucus.*
   Pith elder, Sambucus Canadensis (L.)
2. *Genus Viburnum.*
   Black haw, Viburnum prunifolium (L.)

ORDER ANACARDIACEÆ—SUMACHS.

1. *Genus Rhus.*
   Smooth sumach, Rhus glabra (L.)
   Large sumach, R. typhina (L.)

ORDER PLATANACEÆ—SYCAMORE.

1. *Genus Platanus.*
   Sycamore, Platanus occidentalis (L.)

ORDER MAGNOLIACEÆ.

1. *Genus Liriodendron.*
   Tulip tree (called yellow poplar), Liriodendron tulipfera (L.)

ORDER LAURACEÆ—LAURELS.

1. *Genus Sassafras.*
   Common sassafras, Sassafras officinale (Nees.)

ORDER ARTOCARPACEÆ.

1. *Genus Morus.*
   Red mulberry, Morus rubra (L.)

ORDER HAMAMELACEÆ.

1. *Genus Liquidambar.*
   Sweet gum, Liquidambar styraciflua (L.)

ORDER SAPINDACEÆ—SOAPWORTS.

1. *Genus Æsculus.*
   Ohio buckeye, Æsculus glabra (Willd.)

ORDER BIGNONACEÆ.

1. *Genus Catalpa.*
   Catalpa, Catalpa bignonioides (Walt.)

ORDER BERBERIDACEÆ.

1. *Genus Berberis.*
   Berberry, Berberis vulgaris (L.)

ORDER ANONACEÆ.

1. *Genus Asimina.*
   Common papaw, Asimina triloba (Dunal.)

ORDER EBENACEÆ.

1. *Genus Dyospyros.*
   Persimmon, Dyospyros Virginiana (L.)

ORDER ERICACEÆ.

1. *Genus Oxydendrum.*
   Sorrel tree, Oxydendrum arboreum (D. C.)

ORDER CONIFERÆ.

1. *Genus Juniperus.*
   Red cedar, Juniperus Virginiana (L.)

GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT ON

THE TIMBERS

OF THE

DISTRICT WEST OF THE TENNESSEE RIVER,

COMMONLY KNOWN AS THE PURCHASE DISTRICT.

BY L. H. DEFRIESE.

STEREOTYPED FOR THE SURVEY BY MAJOR, JOHNSTON & BARRETT, YEOMAN PRESS, FRANKFORT, KY.

INTRODUCTORY LETTER.

N. S. SHALER, *Director Kentucky Geological Survey:*

DEAR SIR: In the following report on the timbers of that part of Kentucky lying west of Tennessee river, some distinctive features of that district will be noticed. First, that the timber changes are due not, as in the parts of Kentucky previously studied by me, to geological changes, but mostly to topographical changes. Second, that the whole of the Purchase is comparatively level. Third, that a very small change of level usually produces a marked effect upon the timbers, and thus prevents the monotony which might be expected. Fourth, that no other part of Kentucky offers such facilities for studying the ultimate effects upon the timbers of the fires by which the woods were regularly burned for a great number of years. I have endeavored to make the most of my limited opportunity for observation in all these directions.

I wish to tender my thanks to the people of the Purchase for kindness shown me while I was among them.

Very respectfully,

LAFAYETTE H. DEFRIESE.

NEW YORK, November, 1877.

REPORT ON THE TIMBERS OF THE DISTRICT WEST OF THE TENNESSEE RIVER.

GENERAL REMARKS—GEOLOGY AND TOPOGRAPHY.

There is probably no part of Kentucky where topography has more, and geology less, to do with the distribution and general character of the timbers than in what is known as the Purchase—that is, that part of the State lying west of the Cumberland river. From this it may be inferred, at once, that the species of timbers met with are pretty much the same throughout the entire seven counties which go to make up the region under discussion. There are upland timbers and lowland timbers, but there are few of those marked changes in forest growth which one meets with where timbers are more influenced by geological structure than by topography. Of geological change, if we except one or two spots where the limestone extends across the Cumberland river, there is none sufficient to affect timber growth. The whole of this Purchase region, with the exception mentioned, is apparently of tertiary age, and consists of more or less rounded whitish or reddish pebbles. In what may be called the bed-rock of the region, these pebbles are cemented together with clay, containing a good deal of iron, into an extremely hard and tough reddish conglomerate, called by the people *iron cement*. Overlying this cemented rock there is a bed of loose pebbles and sand varying from a few inches to fifty feet thick. Where the pebbles themselves form the surface of the soil, it is needless to say that the timbers consist of black jack and scrub oak. There are no mountain axes in this part of Kentucky to diversify the topography, but, owing to the peculiarity of the formation, a difference of level of only a few feet will, in most localities, completely change the character of the timber. From this it follows that the number, size, and distribution

of streams are of the greatest importance in considering the present and future value of these Purchase timbers. The streams are important in considering the *future* value of the timbers, because, as I have previously shown,* wherever the white oak is the principal forest tree, other timbers are succeeding it as fast as it is cut away. This succession takes place much slower on bottom lands than elsewhere, for there are few swamp timbers to supplant white oak, and there is no danger of upland timbers doing so along streams. The water timbers are strongly marked, and it seems impossible that they could ever be supplanted by upland timbers. So there is far less tendency in swamp white oak to disappear along the streams, than there is in the upland white oak to disappear from the body of the Kentucky forests. The same may be said of other swamp timbers, so that the number and character of the streams are very important.

A glance at the map of this part of Kentucky will show that, in these seven counties, there are no less than five streams of importance, along all of which the timbers are very fine indeed, and are likely to remain substantially the same in kind. Besides these large streams, smaller creeks and branches form a perfect net-work over the greater part of the region. Leaving out of consideration the timbers along these streams, the forest growth varies considerably in these counties. Speaking generally, the timbers through the eastern parts of Marshall and Calloway counties are good, as are also those through the western parts of Hickman and Ballard.

A belt extending directly through the Purchase country, embracing less than one third of it, with its centre line passing through Mayfield, will contain about all of the poor timber to be found in this entire corner of Kentucky. And, inasmuch as Mayfield creek passes through almost the entire length of this central belt, and its tributaries and those of Little Obion river ramify through it in every direction, along all of which streams the timbers are very fine, it will be seen that this

*See Report on Tradewater Timbers.

comparatively poor strip of forest country is not devoid of valuable timber growth. There is an area of more or less flat table land lying south of Wadesboro, between East Fork of Clark river and the head waters of Mayfield creek, in which, if we except a few small streams, no water is to be found. I call especial attention to the position of this strip of table land here, for it becomes of importance further on in the Report, in the discussion of the succession of timbers.

DRAINS UPON THE TIMBER AND THE TIMBER RESOURCES OF THIS DISTRICT.

At Paducah there are several extensive timber establishments, the principal of which are those of Langstaff, Orm & Co., and McKnight & Co. The former firm claims to have the fastest saw in the world, with which they cut 8,204 feet of lumber per hour. They average 80,000 feet of lumber per week the year round, and keep their yard stocked with 2,000,000 feet of ready-sawed and dried lumber. The principal timbers cut are, of course, white oak and liriodendron (yellow poplar); but, in addition to these, are also elm, ash, hickory, sweet gum, cotton tree, yellow pine, cypress, walnut, cherry, etc. The white oak, gum, and cypress are obtained, to a considerable extent, from the State of Kentucky, from which they get about one third of their timbers. The value per thousand feet of these timbers, in the log, at Paducah, is as follows: Oak, $6 to $10; poplar, $5 to $8; walnut, $10 to $15; white hickory (second growth), $10; sweet gum, $3 to $5; cotton-wood, $3 to $5; pine, $8; cherry, $10 to $15, and so on. McKnight & Co. saw 2,000,000 feet of lumber annually, about 50,000 feet of which is walnut. More than two thirds of all the timber sawed in Paducah is brought down the Tennessee river, which forms a convenient and cheap means of transportation for the vast forests that crowd its banks from its mouth to its head. However, the Paducah lumber establishments have largely drained the lower Tennessee district, and the timbers are now floated down from far above. The time will come, though I think not soon, when the Purchase

region and the Tradewater country will be called upon to furnish the timbers which are now furnished by the upper Tennessee. The only practical difficulty in the way is, that Clark river, the only stream penetrating the Purchase which is available for floating timber to Paducah, is so flat and sluggish, and has so little fall, that the floating of any considerable raft of timber upon it will be a matter of some difficulty. The admirable timbers that grow all along the smaller streams of the Purchase country can be reached only by local saw-mills or by railroad. Lumber establishments at Hickman can float timbers down Mayfield creek and Obion river.

At present, so far as I am aware, the drain upon the timbers of the Purchase region comes from the establishments at Paducah and from local mills. The two Paducah firms mentioned above saw an average of 6,160,000 feet of lumber annually. Not more than one third of this amount is obtained from Kentucky, and, at most, not more than 2,000,000 feet of it can come from the Purchase. If we count an average of ten good lumber trees to an acre, which would be a low average along the streams in this part of Kentucky, and allow 500 feet of sawed lumber for each tree, which would also be a low average, we shall have 5,000 feet of good lumber in each acre of ground. At that rate, these two firms, to obtain their 2,000,000 feet of lumber, annually strip 400 acres of ground of its valuable timbers. That is very little, compared with the hundreds of thousands of acres of fine timbers lying along all the streams in this part of Kentucky. It is impossible even to estimate the amount of timber used by the local saw-mills, which are scattered along all the streams wherever a good body of timber is to be found, and which change their location as the timber is exhausted. I think it safe to say, though, that they saw from 3,000,000 to 5,000,000 feet of lumber annually. If this be true, at the estimates given above, they now clear-up from 500 to 800 acres of timber land yearly, and something like an annual timber drain of 1,200 acres is made upon the Purchase country. This tim-

ber, in the unsawed log, is worth about $50,000. There are not less than 500,000 acres of land in the Purchase which will come within the above estimate of timber production; so, at this estimate, only about one four hundredth of the valuable timbers is now cleared-up annually. At this rate, the timbers can easily reproduce themselves, and the drain is not at all an alarming one. At the same rate, considering one third of the land to be under cultivation, the present forest of the Purchase alone would be worth $10,000,000 or $15,000,000. Even if the present drain upon the Tennessee river country were all turned to the Purchase, less than 2,500 acres of timber annually would be destroyed, or only about one two hundred and fiftieth of the whole. The forests could easily reproduce themselves at that rate, except in the upper woodlands, where, as I have elsewhere shown,* other timbers take the place of the white oak as that is cut away. Of course, all this timber wealth is not immediately available, and it is well that it is not so. Upon the whole, there is not much to be feared in regard to the present or future timber supply of the Purchase region. It is scarcely possible that a greater demand than the last estimate will be made upon it at any time in the near future. When such demand is made, however, it will probably be concentrated along the Clark river, where the facilities for cheap transportation are best, and, in that case, a few years would suffice to strip this stream of its most valuable forests. But the reserve supply of timbers, as I have shown above, is so great that no prospective demand can cause a dearth of them.

There is one great difficulty, as I have previously hinted, in getting at the splendid forests of the Clark river region, and that is, that the stream is comparatively shallow, its bottom very flat, and the water sluggish. The difficulties of rafting on such a stream are greater than they would at first seem. For instance, the lumber establishments at Paducah desire their logs brought to them in their entire length, varying from thirty to seventy feet, so that they can cut from them plank of

*Report on Tradewater Timbers.

any length demanded by their customers. The finest timbers on Clark river are hickory and white oak; but a green hickory or white oak log, forty to sixty feet in length, will not float and it takes great buoying power to keep it up. Not only is Clark river too shallow for such logs, but it is not wide and open enough to allow the passage of rafts large enough to support them. On the Tennessee river, a wide raft of tens of thousands of feet is formed, in which such logs as these alternate with seasoned poplar, which is sufficiently buoyant to support the whole. The stream is broad and deep enough, and has sufficient fall to allow of the easy transportation of these enormous rafts. Of course the only way out of the difficulty is to form small rafts, of only a few logs; but as it is comparatively a good deal more expensive to float a small raft than a large one, we need not expect to see much demand for the Clark river timbers, until those along the Cumberland and Tennessee rivers have become sufficiently scarce and inconvenient of access to render the cost of procuring them as great as that of floating the Clark river timbers.

TIMBER VARIATIONS.

The timbers in this part of Kentucky differ very little, in kind, from the timbers on the older formations of the State. The only new timber met with is the cypress (bald cypress), which is now found immediately on the banks of all the larger streams, on all marsh lands and swampy grounds. Its presence is not due to the formation, for it appears elsewhere from New Jersey southward, on various formations. Why it does not appear in other parts of Kentucky, I do not know, unless it be that a low, level, moist country is required for its growth. But changes of timbers are often, so far as can be discovered, capricious. Magnolias are found in great abundance on the upper Cumberland; down towards the Ohio I have not met with a single one. So it may be, so far as regards geological formations, with the cypress. The timber is light, fine-grained and durable, and

the trees along the large streams, in this part of Kentucky, grow to a height of eighty to one hundred feet, with trunks from three to seven feet in diameter.

There is a marked peculiarity in regard to the growth of the beeches in the Purchase. They are not found in great numbers along the large streams, as they are in the Rough creek region, along the North Cumberland, and in nearly every other part of Kentucky. Along the principal streams, here, very few beeches are met with, and they can hardly be said to form a part of the timbers along Clark river, Little Obion river, and Mayfield creek. They are scattered through the bottoms of small streams, but are not conspicuous even there. A Kentucky swamp without beeches strikes one peculiarly. I could not see any reason for their general absence from the bottom lands of this part of Kentucky.

The abundance of Spanish oak in the Purchase country is worthy of note. Nowhere else, here, have I seen that timber form so conspicuous an element of the forest growth.

Hickory does not form a large percentage of the upland forest timbers, and one will often travel for a mile or two without seeing a single hickory tree. Along the streams and on low grounds, however, the hickory is very fine and valuable. I know of no finer bodies of hickory timber in this country, than are to be found along Clark river and Mayfield creek. The shagbark, pignut, and white hickories are the finest varieties, and of these I have often counted, within sight of where I stood, a dozen which would average ninety feet in height, with diameters of from two to four feet.

Chestnut, whose unaccountable presence on one side of Green river, and absence on the other side, I noticed in a former report (Tradewater Timbers, vol. V, this series), seems to be as arbitrarily distributed in the Purchase as anywhere. About five miles from Benton there is a little creek running into East Fork of Clark river, called Chestnut creek. It heads up between two high hills, whose faces form a topographical synclinal. On these two hill slopes, facing each

other, a few chestnut bushes are found; but they stop absolutely and abruptly at the tops of these two slopes, and on the other sides of the same hills not a chestnut bush is to be found. Nor is there any chestnut in any other part of this section of the country. I was told that there were a few bushes five or six miles off on Middle Fork, but I did not see any. How these chestnut bushes came to grow upon the faces of these two hills I cannot imagine; for they could not have come from seeds floated down the stream, inasmuch as the mountain above the head of the stream has no chestnut on it, and never has had any so far as I could find out. The people have recognized the peculiarity of the growth, as is indicated by the name of the stream. A few chestnut bushes were found in one or two other spots in the Purchase, whose presence and limited distribution are as hard to account for as those of the Chestnut creek timbers.

There is a considerable amount of black walnut scattered through the Purchase country, most of which is found high up on the heads of streams. There is more or less of it found on the head waters of all the streams, but an especially large quantity is met with on Brush creek and on the streams that form the North Fork of Obion river. There is no market for walnut timber in this part of Kentucky and no value is attached to it. It is ruthlessly cut and sawed by the little saw-mills that spring up wherever there is a local demand for lumber. It sells for about three dollars a tree, and a piece of walnut timber that would bring $150 in New York is considered dear at $4 or $5. There is an amount of improvidence shown by Kentucky people in dealing with their forests which would astonish any other civilized people. It is not shown in regard to the walnut alone. In the wide flat woods south of Paducah there is considerable valuable white oak, which is all the more valuable because it is within a few miles of its best market; but I constantly noticed the people cutting this white oak for fuel, notwithstanding the woods are full of Spanish oak and black oak, which make fully as good fire-wood, and are valuable for nothing else. As a rule, the tree nearest to the house

of the owner is the first one sacrificed, regardless of its value. Within a few years, by the time the timber establishments of Paducah turn to the Purchase for their supplies, this flat woods will be almost stripped of its white oak timber, and only the Spanish oak and black oak, which are everywhere succeeding the white oak, though comparatively valueless, will be left as "brands snatched from the burning."

The distribution of the liriodendron (poplar) timber in the Purchase is about the same as that of the white oak. It is found in great abundance on nearly all the streams, large and small, and the principal demand for it is that made by local mills, which, of course, waste large quantities of it. But the reserve supply for future use is so great that no present apprehension need be felt. The finest body of upland white oak and liriodendron in this part of Kentucky is probably between Dublin and Clinton, near the line of the two western railroads across the Purchase. To this statement a rather curious exception must be made. About six miles from Clinton the white oak suddenly disappears, even from low grounds, and on a belt about one mile wide it is almost wholly absent. Here, black and Spanish oak are very fine and heavy, and with them are liriodendron, white elm, etc. About seven miles from Clinton the white oak abruptly begins again, and forms, as it did before, about forty per cent. of the forest growth. I cannot account for this gap in the white oak, unless it be that long ago a hurricane passed through the region and destroyed all the timber in its track, in which case, as I have elsewhere shown, Spanish and black oak would succeed the white oak in the new forests.

In the flat woods south of Paducah, referred to above, the timbers often alternate most curiously. Here white oak is the principal, almost the only, timber; two hundred yards distant, Spanish oak and black oak have succeeded the white oak; at the same distance further on, these timbers have disappeared, and only post oak or hickory is to be seen, and all this without the slightest change of level, or the least apparent reason therefor. In places, all these timbers grow

together; again, they grow only in streaks. After passing this flat woods, there are two principal causes of change in the timbers: one is change of height above drainage, which always produces corresponding changes in the species of timbers; the other is change in the position of the gravel beds relative to the surface of the ground. Underlying the whole of the Purchase country is a bed of pebbles, whose thickness I could not accurately ascertain. This pebble bed is, in some parts of the country, as much as fifty feet below the surface of the ground; in others, for miles, it is on a level with the surface, whose whole formation consists of these pebbles. I did not have the time or the means to investigate the course of these pebble beds, but wherever they lie near to, or form the surface soil, the timbers are very poor, and consist mostly of black-jack and scrub oak. The fine timbers are always found where these beds are at a considerable depth below the surface soil.

I might call attention here, in passing, to two irregular marsh-ponds of the Purchase, one a few miles south of Paducah, the other a few miles north of Mayfield. They are low, undrained marsh lands, the former irregularly round, the latter oblong, and both heavily timbered with swamp timbers. Buzzard pond, as the one near Paducah is called, contains a great deal of bartram oak, over-cup, the people call it. Cypress pond, near Mayfield, takes its name from its principal timber. It is one of the cypress swamps often found in the Southern States.

SUCCESSION OF TIMBERS.

Between Murray and Mayfield there is a considerable area of more or less flat table land, through which no water passes, except the extreme head waters of West Fork of Clark river, and a few other little branches, most of which are dry nearly all the year. I was surprised, after leaving Benton and passing into this table land, to find that the woods consisted only of saplings or tall, slim, young trees, from forty to seventy feet in height, but not more than twelve to twenty inches in

diameter. At a distance, this forest appears very heavy on account of the height and extreme density of these young timbers; but on nearer approach, not an old tree can be found. This peculiar growth extends beyond Murray, and, as I afterwards found, occupies the entire table land, to which I have previously called attention. I examined closely this young forest, and found that its principal timbers are black oak and red oak, and that scarcely a single white oak is to be found. My study of the Tradewater timbers had convinced me, that wherever the present forests of Kentucky are, by any means, destroyed, white oak does not form an element of the new forest growth, but that it is wholly supplanted by black oak and red oak. (See Report on Tradewater Timbers, vol. V, this series.) I at once concluded that the whole forests of this table land had been destroyed thirty or forty years ago, and that the new forest had succeeded that universal destruction of timbers in which the white oak had perished forever. I then passed off into the head waters of West Fork of Clark river and those of Mayfield creek, and noticed that as soon as these streams became large enough to have considerable bottoms, and to have water in their beds the year round, that in these bottoms the old forest timbers, consisting of white oak, poplar, and other timbers commonly met with, still exist. But these timbers are limited strictly to the swamp, at whose margin they give way abruptly to the young forest. Of course, the mystery was at once solved. Fire is the only agency that could destroy the forests over such a wide area, and leave none but the timbers in damp places standing intact. I had before studied the effects of burning off the woods upon the forest timbers, and had pointed out the fact that the people living along the foot of the Black Mountains of Kentucky are rapidly destroying some of the finest timbers in the United States, by pursuing this practice year after year. (See Report on North Cumberland Timbers, vol. IV, this series.) It immediately suggested itself to me that the

cause I had seen in operation in the Black Mountains had completed its work in this part of the Purchase.

I called on Mr. Waterfield, one of the oldest residents of this part of Kentucky, who lives about six miles from Murray, for information. He told me that thirty years ago this whole region of country was a perfect prairie, in which not a single bush was to be found, except along the streams, and that this result was due, as I had suspected, to the practice of burning off the woods yearly, in the late fall or early spring, for the sake of the "range." This practice, when continued year after year, produces two results, both of which I pointed out in speaking of the Black Mountain timbers: it kills off the old forest growth more rapidly than it would be removed by the ordinary agents, by burning and crisping the outer bark every year, and exposing the body of the tree to dampness and decay and the ravages of worms, and it destroys, every fall or spring, the bushes which have grown up since the preceding spring, and which have not yet attained sufficient size to withstand the heat. Evidently, if this process is kept up long enough, the old forest will have passed away, and no new one will have come on to take its place. Suppose this stage to have been reached over an extensive area of almost unwatered country: of course, during the next summer, after the last old tree had passed away and the young bushes had been burned down in the fall or spring, leaving the country absolutely bare, many other young bushes would spring up from seeds and roots still buried in the ground, and, if let alone, would form such a forest as we now see in this part of the Purchase. But if we suppose the process of burning to be continued year after year, it is evident that, before a great many years had passed, the last of the buried seeds would have sprouted, and the last root have exhausted itself and died. We should then have a vast expanse of country, not only without a tree or bush, but without a single seed or root from which one could come. Such are now the great prairie lands of the Western States, and such has been the cause which, in my opinion, led to their barren-

ness of forests. These prairie lands were deprived of their primeval forests by a long continuance of the practice which the Indians pursued of burning off the woods yearly for the purpose of gathering nuts and hunting game. The calamity is irreparable, and Illinois, instead of boasting of the $300,000,000 worth of timbers such as now form the glory of Kentucky, must go through the slow and expensive process of planting and culture to replace the forests which she has so lamentably lost. I am inclined to think that the burning of the woods in the strip of country under discussion did not go so far as to exhaust the buried seeds and roots of the timbers; for, although the strip burnt over is comparatively so small, and so surrounded by heavy forests, that, had such been the case, seeds from these forests would quickly have spread over the burnt area, nevertheless it seems that, in that case, the young trees nearer the margin of the surrounding woodlands would be larger and older than those in the centre of the burnt district. To a certain extent, this is actually the case; but, from a close examination, I came to the conclusion that this appearance was due, not to the fact that the buried seeds and roots over the whole area had been killed and new supplies been furnished from the surrounding forests, but to the fact that, as settlements pushed into these burnt areas, the limits burned over became more and more restricted every year until the burning ceased entirely. This process would give to the present young forest the appearance of being regular and heavy, and yet of gradating into somewhat older growth as one approaches the limits of the burnt district. Besides, inasmuch as the country here slopes toward the north and all the streams flow in that direction, if the forest destruction had been complete and the seeds of the new forest had been furnished from the surrounding old forest, the trees of the new forest would have grown gradually larger as one approached the *southern* limit of the burnt area. The exact opposite is the case, and the young forest trees grow larger as we approach the old forests on the *north* of the burnt district. This shows that the present irregularity of the

young trees is due to the fact that settlements pushed southward in this part of Kentucky, and that the limit of the burnt area was pushed a little further south each year for some years before the burning ceased altogether.

Luckily for the prairie lands of the United States, they are nearly all level, or the loss of their timbers would have led to so great a destruction of the lands themselves, by torrents, that no amount of human labor and ingenuity could ever have retrieved them. If the same process of forest destruction goes on in the mountainous regions of the North Cumberland, until the timbers there are entirely destroyed, nothing can avert from that country the calamity which reckless destruction of forests is now producing in the mountain regions of some parts of Europe. (See Tradewater Timbers, vol. V, this series.)

One of the most important results to be reached from a study of this once burnt district of the Purchase is, however, that my former conclusions in regard to the disappearance of the white oak are correct. Here is a strip of country, surrounded on all sides by vast forests of white oak, such as once evidently occupied this district itself, which is suddenly entirely stripped of its forest growth, except that immediately along its streams. In the new forest which succeeds this destruction scarcely a single white oak is to be found. This, taken in connection with previous observations which showed that the white oak is wanting in the young forest growth in all parts of Kentucky, whatever the character of the old growth, seems to prove conclusively that the white oak cannot hold its own in competition with black oak, red oak, and such timbers.

TIMBER IN DETAIL.

Starting out from Paducah southward along Clark river, for some miles there is found a flat table land with grayish soils, the curious alternation of whose timbers I have previously noticed. Upon this very little undergrowth is found, and what little there is consists almost wholly of black oak and Spanish oak.

In the Clark river bottom, four miles from Paducah, considerable cypress is found. The shag hickory, sweet gum, and white oak, even this near to Paducah, are very fine and heavy, and vary from twenty-four to forty inches in diameter. A good deal of liriodendron, often four feet in diameter, is also found, as well as some white ash, redbud, etc. Black locust and iron-wood are also met with. Six miles from Paducah, about thirty per cent. of the timbers is white oak, and about six per cent. of them liriodendron. Black oak forms about fifteen per cent. of the old forest growth, and of the young forest growth, which is very heavy, about thirty-five per cent. Black, shag, and pignut hickories and Spanish oak are the other forest timbers. These timbers remain essentially unchanged, with the exception of local alterations, for a distance of five miles. Here the road becomes a more or less bare, white sandy ridge, with Clark river off to the right. Along the road, the timbers for some miles are not valuable, and consist nearly altogether of black oak, Spanish oak, black-jack, post oak, and black hickory. On Clark river, the bottom is wide and the timbers are very valuable. On Tennessee river, off to the left of the road as I traveled towards Benton, the valuable timbers are nearly all cut out. White oak and liriodendron, as well as white ash, are found on nearly all the small streams.

About five miles from Benton the country becomes more hilly, and the timbers more sharply divided into upland and lowland timbers. The former are Spanish oak, black oak, post oak, black-jack, and black hickory; the latter are white oak, white ash, liriodendron, white elm, shag hickory, sycamore, and red birch. Bartram oak is also found along all streams. The hilly character of the country continues for about one mile, when the East Fork of Clark river is reached. The swamp land, or bottom, here, is fully two and one half miles wide, and the timbers throughout the whole are of the very finest. The white oak is often four feet in diameter, with height in proportion, sweet gum forty inches in diameter, black and shag hickory thirty-six inches in diameter, with beautiful trunks, sixty feet in height without a limb.

Bartram oak is very heavy, and white elm is good and plenty. Liriodendron is not very large, nor are white and black ash. The best have been cut out right along the road by a small saw-mill near the crossing. But those timbers are very fine all through the Clark river bottom, and as this is usually from one to three miles wide, there lies along it a vast body of exceedingly valuable timbers.

Between Benton and Watch creek, two miles from Benton, towards Murray, the road is hilly and the timbers poor, consisting of red oak, black oak, and post oak, black jack and black hickory. On Watch creek, the usual lowland timbers are found—white oak, liriodendron, black walnut, sycamore, birch, white elm, and red elm, with some shag hickory. After crossing Watch creek, for a distance of five miles, there is alternate hill and level. The surface soil in these levels is composed of whitish gravel, which is not cemented together. The timber is almost wholly black-jack. Even on Wade's creek there is little change in these timbers. Immediately along the banks of the creek, most of the swamp timbers are found, but they are not large nor valuable, except near the mouth of the creek, where they become similar to those of East Fork of Clark river. If we except along Rockhouse and Bee creeks, on both of which good liriodendron, white oak, black and white ash, white hickory and black walnut are found, the timbers are very poor through the high, hilly country from Wade's creek to Murray. The timbers along East Fork are very valuable even this high up; but the river bottom is growing much narrower, and the body of timber along it much smaller. The timbers remain essentially unchanged from Murray to the Tennessee line.

In turning from Murray, back toward Mayfield, one enters upon the level sandy table land before referred to, where the entire forest consists of bushes. These bushes are tall and slim, and stand so thickly on the ground that the forest could never be worth very much even if the timbers were valuable in kind; but this they are not. Of these timbers, black oak forms about forty-five per cent, red oak and scrub hickory

fifteen per cent. each, post oak thirteen per cent, Spanish oak nine per cent., and white oak two per cent. Black-jack alternates with black oak, and in some places is the only timber met with. From this composition we can form an instructive idea of what is to be the future forest of Kentucky, in case no action is taken to perpetuate the present distribution of timbers.

The monotony of this young forest growth is broken on reaching West Fork of Clark river, where timbers very similar to those of East Fork are found, except that the bottom of West Fork is narrow, and the timbers are proportionally small and unimportant. White oak, sweet gum, and liriodendron are its most valuable timbers. After crossing West Fork, the country is somewhat more broken; but the same young forest is met with until one nears Farmington. Here the timber, though still all young and of the same composition, is evidently older than that between Farmington and Murray, and clearly shows that the practice of burning off the woods ceased here before it did in the latter locality.

About five miles from Mayfield the old forest growth is reached again, with considerable white oak, laurel oak, and pig hickory in the lower grounds, and post oak, black oak, Spanish oak, and black-jack in the higher grounds. A change of level of fifteen feet is sufficient to produce this change in the timbers. About three and a half miles from Mayfield, Mayfield creek is reached, and the timbers become very valuable. They consist of white oak and liriodendron, which, together, form about forty per cent. of the swamp timbers, sweet gum, shag and white hickory, black ash and white ash, cypress, bartram oak, winged elm, and swamp laurel oak. A small saw-mill near the creek crossing does a great deal of local work. The timbers along Mayfield creek are every where very fine, and as the bottom is wide and the creek very tortuous, running through more or less of five counties of the Purchase, the body of timber that lies along it is very valuable. It will be difficult, however, to float out a large part of this timber, because, during a

considerable part of its course the creek is not large enough to float out timber, and even where it is large enough, the sluggishness of its waters is a practical difficulty.

After crossing Mayfield creek, there is a stretch of country about ten miles across, between Mayfield and Clinton, which is very hilly, and whose timbers are not valuable. They consist nearly altogether of black oak, Spanish oak, black hickory, post oak, and black-jack. Very little white oak is found and less liriodendron. This lasts until the head waters of Skegg's Fork and of Bowen's creek are reached. South of this strip of comparatively valueless timbers, however, there is a section of country whose forests are very fine: I mean that belt of country comprising the numerous creeks that form the head waters of Mayfield creek and North Fork of Obion river. This section, about fifteen miles square, is a perfect net-work of creeks, no less than eighteen of which flow across it in some way or other. The timbers along these head-water creeks are very heavy and dense, and the white oak, liriodendron, hickories, etc., are of the finest. Here, too, are found the most valuable old forest walnut trees to be met with in the Purchase. Bayou de Chien creek heads in near this section also, and contains along its bottoms a valuable body of timbers, similar to those of Mayfield creek and Clark river.

Going farther north again, about ten miles from Mayfield, toward Dublin, one enters upon a tract of country where the surface gravel wholly disappears, and is found at a depth varying from twenty to forty feet. Here the general forest timbers become good again, and pignut hickory and white oak extend to the hill-tops. About two miles from Dublin the forest is splendid, and furnishes white oak, liriodendron, hickories, white elm, black locust, redbud, etc. On the high hills black oak, Spanish oak, and red oak are found. The white oak through here forms fully forty per cent. of the forest timbers. Turning northward from Clinton, the timbers remain about the same as those between Dublin and Clinton until North Fork of Obion river is reached. Here the white oak,

hickory, liriodendron, sweet gum, bartram oak, and cypress are unsurpassed. The bottom of North Fork varies from one half mile to three miles in width, and is a broad belt of the most beautiful and valuable timbers throughout the entire length of the river. A great quantity of pin oak and swamp laurel oak is also found on North Fork.

After passing North Fork the country is rather hilly again, until the region of Little Mayfield creek is reached. Through this hilly section, however, there is a great deal of white oak and liriodendron, the latter amounting to an average of probably eight per cent. of the forest timbers. There is a valuable body of timber off to the east of Blandville, on the net-work of creeks, consisting of Wilson's Fork, Mahon's creek, Sugar creek, and others which are tributary to Mayfield creek. Of course, the bottom lands on Mayfield creek grow wider as we approach its mouth, and the body of timbers along its banks grows more extensive and valuable. But north of Milburn, before reaching the net-work of creeks referred to, there is a section of country where the white oak ceases to be a forest timber. It is found only on the lowest spots of ground, and, elsewhere, is superseded entirely by black oak and Spanish oak.

About thirteen miles from Paducah, on the Blandville road, we again meet with the more or less grayish table land lying south of Paducah, throughout which white oak, black oak, Spanish oak, post oak, and black hickory are irregularly scattered, alternating one with another in a seemingly unaccountable way.

TABLES.

The following are tables of the timbers met with in various parts of the Purchase. The areas usually cover twenty-five hundred square yards of ground, more or less, are chosen at intervals of four to eight miles along the road, and are as nearly representative as such tables could be made. They are given in the order in which they were taken, which will be gathered from the previous section, "Timber in Detail."

Name.	Number.	Average diameter.	Cut.	Decayed.
White oak	16	20 inches	3	2
Post oak	10	19 "	0	1
Black oak	3	18 "	0	0
Black hickory	3	16 "	0	0

Undergrowth of black oak and black hickory. Small growth of black gum, dogwood, black sumach, and winged elm. Small growth refers to the comparatively small and unimportant timbers, and is distinguished from undergrowth or bushes. Location, two miles from Paducah.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	8	20–32 inches	0	2
Black oak	5	22 "	0	4
Liriodendron	2	28 "	0	0
Black hickory	5	20 "	2	0
Shag hickory	3	18 "	0	0
Pig hickory	2	16 "	0	0

Bushes consist chiefly of black oak and red oak, though about five per cent. of white oak is found among them. Small growth, as in last section. Location, a flat ridge bordering Clark river, about five and a half miles from Paducah.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	2	22 inches.	0	0
Black oak	7	21 "	2	2
Red oak	2	19 "	0	1
White elm	1	20 "	0	0

Black hickory is in the neighborhood, but not in this section. Black oak, red oak, and white oak are about evenly divided among the bushes in this spot—the only place I have noticed where there is a greater proportion of white oak among the bushes than among the old trees. Location, level sandy ridge, about thirteen miles from Paducah.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	16	26 inches.	1	3
Red oak	2	23 "	0	1
Black oak	1	22 "	0	0
Pin oak	1	20 "	0	0

No hickory nor liriodendron in the locality. White elm, black gum, and catalpa are found among the small growth. Location, a depression or hollow about five miles from Benton.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	9	40 inches.	0	2
Bartram oak	3	32 "	0	1
Liriodendron	7	28 "	1	1
Sweet gum	5	35 "	0	1
Black hickory	3	30 "	0	0
Shag hickory	2	28 "	0	0
White elm	3	26 "	0	1
White ash	1	22 "	0	0
Cypress	2	35 "	0	1

The section is on the East Fork of Clark river, four miles from Benton. The swamp here is three miles wide, with timbers as fine all through. Large amount of pin oak, sycamore, red birch, and considerable black ash are also found.

Name.	Number.	Average diameter.	Dead.	Decayed.
Red oak	17	19 inches.	2	4
Black oak	13	20 "	1	2
Spanish oak	3	20 "	0	1

Post oak in this locality, but no hickory. Location, a hill-top, about one mile from Benton.

Name.	Number.	Average diameter.	Dead.	Decayed.
Post oak	8	18 inches.	0	2
Spanish oak	7	14 "	1	2
Black oak	1	16 "	0	0

Among bushes and small growth, in addition, are black hickory, persimmon, dogwood, sassafras, and black-jack. No white oak in the neighborhood at all. These timbers remain unchanged, except on streams and at the bases of hills, till the forest of young timber, previously spoken of, is reached. Location, high ridge, about five miles from Murray.

Name.	Number.	Average diameter.	Height.
Black oak	18	11 inches.	35 feet.
Red oak	5	11 "	30 "
Spanish oak	7	12 "	34 "
White oak	1	7 "	24 "
Scrub hickory	7	8 "	18 "
Post oak (scrub)	6	20 "	35 "

The young timbers are exceedingly thick, on the ground, all over the country, and the table is a good average of their character. The small amount of white oak, and the large amount of black oak, on low and high ground alike, in these woods, which have grown up within twenty-five years, is worthy of notice and earnest consideration. This is the character of the forests until Mayfield creek, three and a half miles from Mayfield, is reached. Location, six miles from Murray, a nearly level table land, very fertile.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	9	24 inches.	0	1
Liriodendron	8	30 "	1	1
Sweet gum	6	22 "	0	0
White hickory	1	24 "	0	0
Shag hickory	2	20 "	0	1
Pin oak	2	22 "	0	0
Bartram oak	3	26 "	0	1
White ash	1	25 "	0	0

Winged elm, black gum, water birch, maple, sycamore, and cypress are also found in the locality, which is Mayfield creek bottom.

Name.	Number.	Average diameter.	Dead.	Decayed.
Black oak	10	20 inches.	1	2
Spanish oak	8	22 "	0	1
Red oak	4	21 "	0	0
Post oak	4	20 "	0	1
White oak	1	18 "	0	0
Black-jack	1	16 "	0	0
Black hickory	3	18 "	0	0

White oak and liriodendron not numerous in this locality. The oaks in the table alternate as leading timbers here. There is a good deal of white oak in the forest here, but none of note in the locality of the table. Location, more or less level, ridge country, about seven miles from Mayfield, toward Clinton.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	13	20–44 inches.	1	3
Liriodendron	5	40 "	0	2
Sweet gum	6	28 "	0	2
Spanish oak	3	25 "	1	0
Black oak	4	35 "	0	1
Bartram oak	3	30 "	0	0
Pig hickory	2	26 "	0	1
Shag hickory	3	25 "	0	0
White ash	2	24 "	0	1
Black ash	1	22 "	0	0
Red elm	2	28 "	0	0

Cypress exists in great plenty right along the banks of the river. Location, North Fork of Obion river, between Dublin and Clinton.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	12	26 inches.	1	2
Spanish oak	3	24 "	0	1
Post oak	2	20 "	0	0
Black oak	4	26 "	0	1
Liriodendron	2	25 "	0	0
Pig hickory	2	24 "	0	0
Black hickory	1	26 "	0	0

The white oak through here forms about forty per cent. of the forest timbers, the liriodendron about four or five per cent. Hickory is very fine. Undergrowth mostly of black and Spanish oak, with some post oak, considerable hickory, and small amount of white oak. Location, open upland forest, between Dublin and Clinton.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	14	30 inches.	1	2
Liriodendron	7	28 "	0	0
Swamp laurel oak	6	26 "	0	0
Bartram oak	4	28 "	0	1
Red oak	3	27 "	0	1
Sweet gum	7	30 "	1	0
Cypress	2	34 "	0	1

White elm, white and shag hickory, black and white ash, pin oak, etc., are found, but not in this section. Location, Little Obion river, about seven or eight miles north of Clinton. The hickory and white oak are very fine.

Name.	Number.	Average diameter.	Dead.	Decayed.
White oak	21	25 inches.	1	3
Liriodendron	8	26 "	0	1
Black oak	1	20 "	0	0
Spanish oak	1	22 "	0	0

Pig and black hickory are in locality, but not in the section. Location, the forest along the net-work of creeks south of Lovelaceville. Dogwood, alder, persimmon, winged elm, etc., are small growths.

Name.	Number.	Average diameter.	Dead.	Decayed.
Post oak	19	21 inches.	0	3
Black oak	5	24 "	0	2
Spanish oak	1	18 "	0	0

No hickory; bushes mostly black oak. Location, an average hill-top in the forest a few miles east of Blandville.

Within twelve miles of Paducah, we pass into a flat, whitish-gray table land, whose timbers are similar to those noted on leaving Paducah and going southward on the eastern side of the Purchase.

From the foregoing tables, some interesting information can be deduced in regard to the timbers of the Purchase country. For instance, taking up the white oak, we form the following general table.

Name.	Average diameter.	Per cent. decayed.	Per cent. dead.
White oak	26 inches.	16⅔+	5+

That is, the general average of the white oak timber throughout the Purchase shows a diameter of twenty-six inches, with sixteen and two thirds per cent. of the timber decayed.

Similar tables for the other principal timbers are as follows:

Name.	Average diameter.	Per cent. decayed.	Per cent. dead.
Liriodendron	29 inches.	13 nearly.	5+
Black oak	22½ "	26 "	7½ about.
Post oak	20 " nearly.	16⅔	not 3.
Spanish oak	22 " +	20+	8 nearly.
Hickories	22 "	3+	6+
Sweet gum	28¾ "	12½	4+
Red oak	21¾ "	25	7+
Bartram oak	30 "	25	not 7.

From these tables, it appears that the bartram oak has a larger average diameter than any other tree in this part of Kentucky, and liriodendron stands next to it. We should expect that, for the bartram oak is a large tree, and then it is never found, except in swamps and low places where the timbers are always larger than on uplands. Post oak has the smallest percentage of dead timbers, and next to it comes the sweet gum, followed by white oak and liriodendron, with the

same percentages. Black oak stands first among decayed timbers, and bartram oak next. Hickories are by far the soundest timbers, and have a smaller percentage among their decayed than among their dead trees. It will be noticed, also, that as a rule, swamp timbers are sounder than upland timbers. This would have been expected.

From the tables already given, other series may also be produced. For instance, the following list shows the relative numbers of different timbers to be met with.

White oak, 121; bartram oak, 13; black oak, 54; liriodendron, 39; hickories, 32; post oak, 43. That is, there are one hundred and twenty-one white oaks to fifty-four black oaks, throughout the old forests, in this part of Kentucky, and so on. I do not think there is as much liriodendron timber as hickory in the woods; but the valuable liriodendron is more plentiful than the valuable hickory, as the table shows. Again, if we consider the timbers given in the "general average" tables above, to be all the forest timbers in the Purchase (and they are at least ninety per cent. of them), white oak forms about thirty-two per cent. of all the forest timbers, and black oak comes next, forming less than fifteen per cent. If the estimate of the value of the standing forests of the Purchase previously given be correct, the white oak alone now standing in this comparatively small strip of Kentucky, is worth from $3,000,000 to $5,000,000. It remains for the people, by prudence and forethought, to perpetuate a timber which is, in itself, a fortune to them.

SUMMARY.

A brief survey of the foregoing pages shows:

1. That there are vast bodies of valuable timbers lying along all the streams of the Purchase country, but that these streams are not well adapted for floating them out.

2. That as much as two thirds of the upland of this part of Kentucky is clothed with valuable timbers.

3. That there is not, at present, much drain upon the forests of the Purchase, and that not more than one two hundred and fiftieth of these forests is likely to be called for per annum, at any time, in the immediate future. At this rate they can easily reproduce themselves, with the exception of the white oak, which does not tend to perpetuate itself. Of course, the *available* timbers will be the ones drawn upon, and they would be exhausted in a few years, comparatively, at such a drain as I have considered possible in the future.

4. The white oak forms about thirty-two per cent. of the forest timbers in the Purchase, and, alone, would be worth, at Paducah, the enormous sum of $3,000,000 to $5,000,000. The total forests of the Purchase are estimated at from ten to fifteen millions of dollars in value.

CUPULIFERÆ—MASTWORTS.

1. *Genus Quercus.*
   - White oak, Quercus alba (L.)
   - Swamp white oak, Q. bicolor (Willd.)
   - Red oak, Q. rubra (L.)
   - Pin oak, Q. palustris (Mx.)
   - Spanish oak, Q. falcata (L.)
   - Black oak, Q. tinctoria (Bart.)
   - Post oak, Q. obtusiloba (Mx.)
   - Bartram oak, Q. heterophylla (Mx.)
   - Black-jack, Q. nigra (L.)
   - Laurel oak, Q. imbricaria (Mx.)
   - Swamp laurel oak, Q. Laurifolia (Mx.)
2. *Genus Castanea.*
   - Chestnut, Castanea vesca (L.)
3. *Genus Fagus.*
   - Common beech, Fagus sylvatica (L.)
   - Red beech, F. ferruginea (Ait.)
4. *Genus Ostrya.*
   - Hop hornbeam or ironwood, Ostrya virginica (Willd.)

JUGLANDACEÆ—WALNUT.

1. *Genus Juglans.*
   - Black walnut, Juglans nigra (L.)

2. *Genus Carya.*
   Shagbark hickory, Carya alba (Nutt.)
   Black hickory, C. tomentosa (Nutt.)
   Pignut hickory, C. glabra (Sorr.)
   White hickory, C. microcarpa (Nutt.)

ACERACEÆ—MAPLES.

1. *Genus Acer.*
   Red maple, Acer rubrum (L.)
   White maple, A. dasycarpum (Ehrh.)
   Sugar maple, A. saccharinum (L.)
   Black sugar maple, A. nigrum (Mx.)

CORNACEÆ.

1. *Genus Cornus.*
   Flowering dogwood, Cornus florida (L.)
   Low cornel, C. canadensis (L.)
2. *Genus Nyssa.*
   Black gum, Nyssa multiflora (Wang.)
   Swamp black gum, N. uniflora (Walt.)

BETULACEÆ—BIRCHWORTS.

1. *Genus Betula.*
   Red birch, B. nigra (Ait.)
2. *Genus Alnus.*
   Smooth alder, Alnus serrulata (Willd.)

OLEACEÆ.

1. *Genus Fraxinus.*
   White ash, Fraxinus Americana (L.)
   Black ash, F. sambucifolia (Lam.)
   Blue ash, F. quadrangulata (Mx.)

ULMACEÆ—ELMWORTS.

1. *Genus Ulmus.*
   Slippery elm (red elm), Ulmus fulva (L.)
   White elm, U. Americana (L.)
   Winged elm (whahoo), U. alata (Mx.)

ROSACEÆ.

1. *Genus Cerasus.*
   Black cherry, Cerasus serotina (D. C.)
2. *Genus Prunus.*
   Red and yellow plum, Prunus Americana (Mx.)
3. *Genus Cratægus.*
   Hawthorn, Cratægus oxycantha (L.)
   Red haw, Cratægus viridis.

SALICACEÆ—WILLOW-WIRTS.

1. *Genus Salix.*
   Willows—two or three varieties.
2. *Genus Populus.*
   Silver-leaf poplar, Populus alba (L.)

LEGUMINOSÆ.

1. *Genus Robinia.*
   Black locust, Robinia pseudacacia (L.)
2. *Genus Cercis.*
   Redbud (Judas tree), Cercis Canadensis (L.)

ANACARDIACEÆ.

1. *Genus Rhus.*
   Red sumach, Rhus glabra (L.)
   Black sumach, R. typhina (L.)

CAPRIFOLIACEÆ.

1. *Genus Viburnum.*
   Black haw, Viburnum prunifolium (L.)

PLATANACEÆ.

1. *Genus Platanus.*
   Sycamore, plane tree, Platanus occidentalis (L.)

LAURACEÆ—LAURELS.

1. *Genus Sassafras.*
   Common sassafras, Sassafras officinale (Nees.)

ARTOCARPACEÆ.

1. *Genus Morus.*
   Red mulberry, Morus rubra (L.)

BIGNONACEÆ—TRUMPET FLOWERS.

1. *Genus Catalpa.*
   Catalpa, Catalpa bignonioides (Walt.)

MAGNOLIACEÆ.

1. *Genus Liriodendron.*
   Tulip tree, Liriodendron tulipfera (L.)

ANONACEÆ.

1. *Genus Asimina.*
   Common papaw, Asimina triloba (Dunal.)

HAMAMELACEÆ—WITCH HAZELWORTS.

1. *Genus Liquidambar.*
   Sweet gum, Liquidambar styraciflua (L.)

EBENACEÆ.

1. *Genus Dyospyros.*
   Persimmon, Dyospyros Virginiana (L.)

CONIFERÆ.

1. *Genus Taxodium.*
   Bald cypress, Taxodium distychum (Rich.)

GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT

ON A

BELT OF KENTUCKY TIMBERS,

EXTENDING EAST AND WEST ALONG THE SOUTH-CENTRAL PART OF THE STATE,

FROM COLUMBUS TO POUND GAP.

BY LAFAYETTE H. DEFRIESE.

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INTRODUCTORY LETTER.

NEW YORK, February, 1879.

Professor N. S. SHALER, *Director Kentucky Geological Survey:*

DEAR SIR: I herewith submit a report upon a belt of Kentucky timbers, extending from Columbus, on the Mississippi river, to Pound Gap, on the Virginia line.

The data for the report were obtained on a trip made for that purpose during the summer of 1878. The general plan of the report does not differ materially from that of previous reports; but the great extent of country covered by it, and the particular objects in view in this report, rendered necessary considerable differences in detail. Such of these as are important will appear from the body of the report.

Very respectfully,

LAFAYETTE H. DEFRIESE.

REPORT ON A BELT OF KENTUCKY TIMBERS, EXTENDING IRREGULARLY EAST AND WEST ALONG THE SOUTH-CENTRAL PART OF THE STATE, FROM COLUMBUS TO POUND GAP.

PRELIMINARY REMARKS.

In each of the several previous reports made on Kentucky timbers, attention has been called to a comparatively limited portion of country; and all the conditions of timber growth, the relative numbers of the different kinds of timbers, the changes that these several kinds of timbers undergo under certain circumstances of time or position, have been inquired into somewhat minutely, and in a detailed manner. Such previous reports have been occupied, therefore, each in its own locality, with minute examinations and discussions of tree life, growth and changes, and there has not been much effort to direct attention to the similarities and dissimilarities shown to exist, by comparison of reports, on widely separated localities. In other words, each previous report has been detailed in character and limited in locality. This report is intended to be exactly the reverse. It deals with a very wide extent of country, and in a more or less general way. Its principal objects are to embrace under one view timber growths existing under the most widely different conditions possible within the State, and to call attention to any marked changes that may be found to accompany such differences of condition, and especially to discuss the effects of height above drainage upon such growths. A better opportunity for the latter purpose could not be had than presents itself to one who passes from the swamps and hilly, rolling country of Western Kentucky onto the level and fertile Blue-

grass Region of the central part of the State, and thence across the high mountains, deep valleys, and wild ravines of the eastern portion. Almost every variety of topographical and geological condition to be found in the State is met with on this journey, and the corresponding effects of such changes upon forest growths can be seen and studied.

It should be borne in mind, however, in reading this report, that my observations were confined to a very narrow belt on either side of the line of travel; and that, while I brought to my assistance facts obtained from elaborate and minute study in various parts of the State, nevertheless I may have erred at times from having been necessarily confined to so narrow a strip of country. Conditions may exist at one point which are exceptional rather than general, and which, a few miles distant, would cease to exist altogether. Erroneous reasonings may thus arise, which could not be avoided under the circumstances; though, in preparing data, great care has been taken to avoid material error.

Another source of possible error in such a report as this, to which attention should be called at the outset, arises in dealing with comparative heights above drainage. In a rapid trip over so great an extent of country it is impossible to keep a stationary barometer to correct the fluctuations of the instruments carried; so that, in many instances, heights had to be more or less estimated. Such a source of error was unfortunate; for a difference of level of a few feet will often make a material difference in the growth of timbers, and interfere with comparative work.

GENERAL REMARKS.

In passing from the extreme southwestern to the extreme southeastern part of Kentucky, almost a complete change in forest growth will be noted. This singular change—a great part of which I cannot account for at all at present—begins first to be noticed, along the belt covered by this report, in Madison county, in that cluster of hills of which "Big Hill" is the centre and the most conspicuous. An exception to

this statement should be made in the case of linden or basswood trees, a few of which skirt Muldraugh's Hill farther to the west. (By Muldraugh's Hill, is here meant the entire range of hills bordering the Bluegrass Region on the south.) About the vicinity of Big Hill the first pines (*P. mitis*) make their appearance. Not a single coniferous tree or bush, with the exception of the swamp cypress and a few small cedars in Northwestern Kentucky, is to be seen in the entire western part of the State.

The pines first appear on the dry Waverly shales, extending down to the foot-hills along the knobs about Big Hill, and are also found on the Conglomerate, capping the tops of the highest knobs in this region. Their entire absence in Western Kentucky, and their presence in Eastern Kentucky, cannot be due to difference of geological formation, for both Waverly and Conglomerate are found in the western part of the State. Nor can it be due merely to the height of the hills and mountains in Eastern Kentucky; for pines are often found here on hills much lower than many in Western Kentucky. In another place, and under its proper head, I shall give what I conceive to be the reason of this peculiar phenomenon in the growth and distribution of the pine in Kentucky. At present, I wish merely to call attention to the marked difference between the forest growths of the western and those of the eastern part of the State.

In passing from the west to the east, the first hemlock trees (*Abies Canadensis*) were found by Professor Shaler in a Devonian shale ravine, about five miles north of Irvine, in Estill county. In a previous report on the timbers of the North Cumberland (Bell and Harlan counties), I called attention to the fact that, in that part of the State, hemlock appeared only on coal measure formations, and was confined almost entirely to the Conglomerate. The finding of hemlock on Devonian shale, in Estill county, shows that in Kentucky, as in other States, that tree is not confined to particular formations. It should be said, however, that very little hemlock was found on this journey elsewhere than on coal-measures.

The magnolias are likewise first met with not far from Irvine, and between that place and Beattyville, while the American laurels (Rhododendron and Kalmia) are not found until the rockier mountains and wilder ravines farther east and south are reached. The same may also be said of the Amelanchiers and some other smaller shrubs. Thus, within comparatively few miles, and without any *apparent* topographical or geological reason for it, the whole character of the forest growth changes; and while the oaks and hickories of the west remain, there are added to them lindens, pines, laurels, and magnolias—stately and beautiful trees of the east alone. I say, without any *apparent* topographical reason, because these timbers are found alike on the mountains and in the valleys of Eastern Kentucky, while in Western Kentucky they do not appear, even on the highest hills. The same geological conditions can be found in the western part of the State as those on which these timbers grow in the east; so that the only point of difference which suggests itself, is in the higher mountains and hills of the east. It may be, therefore, with some of these timbers, that a wild and mountainous country is a necessary condition precedent to their introduction, and that their subsequent spread over the lower hills and valleys is a matter of course; but this is a subject which would require a great deal of preliminary investigation, before an opinion upon it could be safely hazarded.

Nothing is more certain to attract the attention of students of forestry in Kentucky, than the contrast met with in passing from the splendid woodlands of Muldraugh's Hill onto the Cincinnati limestone of the Bluegrass Region, near Danville. Especially is this contrast striking in Garrard county, which, though one of the finest and richest in the State, is nevertheless, with the exception of a few fenced-up groves, a treeless waste, devoid alike of water and forests. Coursing across it here and there can still be traced the dried-up beds of numerous streams, in which, within the memory of citizens living along them, water continuously flowed. Inasmuch as the Cincinnati limestone is an exceedingly waterless formation, or one

the surface of which is not adapted to the holding and flowing of water, I should have been in doubt whether to attribute the dry character of the country to the destruction of the timber or to the formation, had I not been told that water once flowed the year round through the now parched stream-beds. All that can be said is, that the people owe their present dearth to their past thoughtlessness; and the reckless destruction of forests now going on throughout the State portends an even greater calamity before there is a turn for the better. An able investigator of this subject well says: "Since 1835, the forest area of the western hemisphere has decreased at the yearly average rate of 7,600,000 acres, or about 11,000 square miles, and this rate in the United States alone has advanced from 1,600 square miles in 1835 to 7,000 in 1855, and 8,400 in 1876, while the last two years have been scarcely less exhaustive. Statistics for eighty years previous to 1835 show that we have been wasting the supply of moisture to American soil at the average rate of seven per cent. for each quarter of a century during the last one hundred and twenty-five years, and that we are now approaching the limit beyond which any further decrease will materially influence the climate of the entire continent. Many eastern regions, such as Afghanistan, Persia, India, and Asia Minor, once possessed of a fine climate and abundant harvests, are now often scourged by pestilence and famine; and it is altogether probable that their misfortunes began with the disappearance of their native forests. It is quite likely that we shall suffer in climate, fertility, and health before a great while, if we continue to destroy our trees as recklessly as we have done, and it behooves us to be warned in time. * * * For one hundred and fifty years we have been felling the forest; for the next one hundred and fifty we should try to restore what we have taken away."

In previous reports attention has been called to the fact that certain timbers, especially white oaks, do not seem to return again to forests from which they have once been driven by such an agency as fire. It has also been men-

tioned, that the formations best adapted to the growth of chestnut timber are the Conglomerate and Chester sandstones. On soils from these formations chestnut is normally found in the greatest abundance, and growing to the greatest perfection. In passing from Western to Eastern Kentucky, my attention was therefore attracted to the fact that when the Big Clifty (Chester) sandstone first appeared, which was in the neighborhood of Hopkinsville and on Pilot Knob, no chestnut appeared with it. Moreover, the white oak and liriodendron, away from the streams, seemed scrubby and scarce. Otherwise the forest was normal, and I searched in vain for any clue to the absence of these timbers. I finally came to the conclusion that, long ago, the entire country through here, reaching probably as far west as the Cumberland river, had been laid waste by fires, and had been barrens similar to those still remaining in the Purchase, and further east in Barren and other counties.

Mr. Irvine Kennedy, who has lived in this part of Kentucky for sixty-eight years, and who now resides near Elkton, informed me that my conjecture was correct, and that he could remember when all these heavy forests were a uniform growth of young trees, with not an old tree standing, except on streams too large for fires to sweep through their swamps.

I was afterward informed that some chestnut groves exist not far from Elkton, though I did not see a tree. It is possible that they stand in a piece of woods for some reason protected from the ravages of fires. Without special investigation made for that purpose, it is impossible to arrive at anything near the extent of Kentucky forests which represent, not the original growths of the State, but a kind of second growth, sprung haphazard from the burial-place of the primeval forests.

In a previous report on the timbers of the Purchase District (see Report, volume V, this series), attention was called to the remarkable absence of chestnut from that part of Kentucky, although the formation is a mill-stone grit waste, on

which chestnut should be found. A closer examination of the timbers surrounding the present barrens of the Purchase shows that there is very little white oak among them, except along streams and on low grounds. My present opinion is —subject, of course, to correction upon closer study—that the high grounds of almost the entire Purchase, from Tennessee river on the east to the Mississippi on the west, have been swept by fires and denuded of their timbers, and that the only difference between the other forests of this part of Kentucky and the present barrens is one of age. Both are second growths, and in both cases the primitive forests have been swept away by long-continued fires. In this report I give my reasons for believing that in former times the barrens have extended east beyond the Cumberland river, at least as far as Hopkinsville, if not, with local exceptions, to the waters of Big Barren river, leaving the narrow strip between the Tennessee and Cumberland rivers alone unswept by fires. Big Barren river is *probably* the eastern limit, in this locality, of the ancient barrens, part of which are still to be seen along it. The location of the northern limit of these ancient barrens is worthy of special investigation, if the view here advanced be correct, for they have certainly never extended to the Ohio river. Further on in this report I have called attention to certain chestnuts, evidently dropped by passers-by, having sprung up in the Purchase, near Clark river, and died. In this connection, an interesting question presents itself, and that is, whether chestnut and white oak will grow again in a forest once *thoroughly* burnt out, even if planted. If not, it may be that the barrens were never burnt over so long as to kill the roots and seeds of existing timbers, but only long enough to destroy the chestnut, white oak, &c., which would not grow again on the burnt-over grounds. The whole subject is one of the deepest interest, and should be thoroughly investigated.

REMARKS ON SPECIAL LOCALITIES.

There are some peculiarities connected with timber growth in certain localities which are worthy of mention. For in-

stance, speaking broadly and generally, timbers are far better on the north sides of hills than on the south sides. This is doubtless due to the north side of a hill being shadier and damper than the south side, which is exposed directly to the drying heat of the sun. There are some exceptions to the statement that the finest forests grow on the north side of the hill. When the hill is very high, the observation made in the report on the timbers of the North Cumberland, that white oak flourishes best on the south side of the hill, is true. It is also true, even to a greater extent, of pines. If the hill be *low*, the best white oak, as will be noticed further on, like other timbers except pine, grows on the north side; if it be high enough to affect much the temperature of the north side, the white oak is found on the *warm* side; and where white oak is found on the north side of a high hill, it is found right at the base, where it is sheltered, or right on *top*, where the sun reaches it. In the case of the pines, it may be that the method of their distribution, of which I shall speak further on, has something to do with their confinement largely to the southern slopes of hills; but that cannot fully account for the fact, and it must be that the pines of Kentucky are not hardy, and seek the southern sides of mountains for warmth and sunlight.

Again, it would be natural to suppose, inasmuch as there are several belts of distinct timbers on each large hill, each belt composed of those timbers adapted to its height above drainage, that the various species of timbers would shade off gradually in ascending a hill; for instance, that the best white oak would be found at the base of the hill, that that a little higher up would be not quite so good, and that the quality would gradually grow poorer, until the white oak ceased altogether. To my astonishment, this did not seem to be a rule. That is, in descending a hill, the very first trees of a particular species are often as fine as any others found on the hill, unless want of richness of soil prevented. The observation certainly holds good with the beeches, hemlocks, and other timbers with which moisture of soil is the controlling requisite

of growth. They remain of the finest quality till they cease altogether, and their line of growth often forms a sharp and well-defined band around the hill.

As would naturally be expected, the timbers characteristic of a mountain top are not found directly on top of the mountain, but a few feet below the top, on the brow. The reason is, that on the level top there is usually a considerable depth of detritus and decayed vegetable matter, more or less moist, which gives to the timbers somewhat the characteristics of lowland timbers.

SPECIAL TIMBERS.

Reference has already been made to the peculiar, and, in many respects, remarkable distribution of pines in Kentucky. They are not found further west, in the timber belt here spoken of, than the Big Hill region, in Madison and Garrard counties; and the same counties are almost the northern limit of pine growth likewise, though scattering ones may be found on Muldraugh's Hill, still farther north. The pines met with are principally of the *P. mitis* or yellow species, though considerable numbers of *P. rigida* or pitch pine, *P. strobus* or white pine, and *P. taeda* or loblolly pine, are also met with. The question presented by this pine growth is, why is it limited so absolutely and arbitrarily to the southeastern part of the State? Is the reason to be found in the geological formation of that part of the State, or in its topographical nature, or in some problem connected with the original appearance of the pines in the Kentucky forests? As I have already said, the reason cannot be a geological one, for the exact geological counterpart of this section of the State can be found in Western Kentucky, where there are absolutely no pines. The true cause must then be sought in the other two alternatives—topographical nature of the country and method of original appearance and distribution—and I think that these two causes supplemented each other in producing the present peculiarities of pine growth. In order to fully comprehend the matter, let these facts be kept in mind:

1. The pines of Kentucky (hemlock is excepted for the present, and will be spoken of later) require a very dry soil, and for this reason are confined to the rock ledges of the high mountain tops, or to the dry shales of the lower levels. For this reason *pines cannot be distributed by the carrying power of water*, as in that case the seeds would be deposited in low, wet places, where growth would not take place.

2. In a general way, pines gradually increase in numbers from where they are first met with on the north to the southern border of the State, and from where they are first met with in the west to the eastern part of the State. This statement is subject to some modification on account of variations in height of the hills in this part of Kentucky, to be explained presently.

3. Pines are distributed over slopes of hills and mountains facing south and southeast.

A little reflection will show that only one hypothesis will satisfactorily explain all these peculiar facts in relation to the present growth and distribution of the pine; and that is, that the pine forests of Kentucky were introduced at a comparatively late date, and spread, from the vast pine forest and mountain growths of North Carolina, to the south and southeast of this section. Inasmuch as they could not have been distributed by water, for the reason already given, we must look to the wind as the motor power in their distribution. I was informed by all the citizens questioned on the subject that the prevailing winds in Kentucky are *from* the south and west. Of course, it is apparent at once that the pine seeds are carried north from North Carolina by the prevailing southern winds, while the western winds are almost a perfect barrier to confine them to the eastern part of the State. The trees work westward very slowly against the prevailing winds; and when the wind does blow from the east, it is liable to be accompanied by rain, which would destroy its power to carry the seeds to any great distance. If the pine seeds were carried by the winds from the south, of course they would be lodged on the south sides of the hills and mountains, and the pines

would naturally be first found there. I do not say that this is the *reason* why they are found on the south, and not found on the north sides of the mountains, for they would, if conditions were suitable, soon work over from one side to the other. I merely say that, given the conditions here present, the pines would certainly be first found on the south sides of mountains.

It must be said that there are some tolerably strong arguments against the view I have here advanced as to the distribution of the pines, and one of these is, that in the very section of Kentucky where the pines are found, they are by no means uniformly distributed, and oftentimes miles of low hills will intervene without a single pine, and a comparatively solitary high hill will have several on its summit. I can only suggest, in explanation of this, that the high hill-tops are the ones which would most catch the wind-carried seeds, and that, should they be dropped on the low intervening hills, they would probably not grow, unless the formation happened to be one of the dry shales. As I have previously said, my observations go to show that the pines in this part of the State (as also in the Pine Mountains further southwest) grow only on high hill or mountain tops, or else on dry shales, like the Devonian or some of the Waverly shales.

Inasmuch as the hemlock is always found within comparatively few feet, in barometric height, above *local* drainage, and is therefore usually in the hollows and ravines, rather than on the hills, we must look to the water for its distribution. Such seeds as the wind might pick up and lodge on mountain peaks certainly would not grow. To appreciate the peculiar distribution of hemlock, its characteristics must be understood. These I have studied minutely, so far as their growth in Kentucky is concerned, and am convinced—

1. That they do not grow, on the *average*, at a greater height than fifty feet above the local drainage.

2. That, nevertheless they require a *very* dry soil, the more rocky and precipitous, usually, the better. These two conditions can be satisfied only by small mountain streams,

which have a very limited extent of bottom land (hemlock will not grow on bottom land at all), and where the surrounding hills come down to the water edge, forming more or less ravines and precipices. The consequence is, that while the head-waters of the Kentucky river on the one hand, and of the Cumberland on the other, penetrate into the very heart of the hemlock region, and are the mountain streams along which this timber grows to the greatest perfection, yet the Kentucky river does not carry it far northward, nor the Cumberland river far westward. The seeds will be carried downward and deposited by these streams, and will take root and grow, just so long as the above conditions are complied with; but, whenever the streams become large enough to have a belt of bottom lands along them, the possibility of a further spread of the hemlock ceases in Kentucky. The conditions of growth of that timber may be different elsewhere.

It is worth while, in speaking of special timbers, to call attention to a somewhat remarkable forest of beeches, which occupies a belt of country eight or ten miles wide, beginning about three miles from Greensburg, and extending to within about the same distance of Campbellsville, and lying in Green and Taylor counties. The extent of the belt in other directions I could not determine. In this belt, beeches form the forest timbers to the almost entire exclusion of other growths. They not only occupy the valleys, but extend to the tops of the highest hills. The reason is to be found in the formation, which is a reddish, very much decayed St. Louis chert, out of the very top of which the water oozes, and which is therefore always wet. Inasmuch as height above drainage is the principal determinant of beech growth, it is natural that these hills should be covered with such a heavy forest of that timber.

As to the distribution of the magnolias, the so-called American laurels (rhododendron and kalmia), and the linden trees, I confess that I see no reason why they should be confined to the eastern part of Kentucky, unless it be the purely topographical one, that high mountains and deep and ragged

ravines are necessary conditions of their introduction and growth. On the other hand, all these timbers grow and flourish on ground in this part of the State, which has less of those very characteristics than grounds further west, on which they do not grow at all. So far as I can see, the only difference is, that there are high mountains in Southeastern Kentucky, and there are no high mountains in Western Kentucky. The subject of the growth and distribution of these timbers is full of interest, and should be investigated.

I should speak, also, before leaving this head, of the oaks in Kentucky and the West generally. So far as their classification is concerned, they are in a very unsatisfactory condition; and in dealing with them, our botanies are practically worthless. In all of them, the best of which are those of Gray, Wood, and Chapman, the basis of distinction is their leaf or fruit. About the former, a great deal of space is occupied discussing distinctions which do not exist at all; for the leaves of the oaks, with a few marked exceptions given below, shade into one another in such a way that it is impossible to distinguish the trees in that way. It is nearly as bad with the fruit, with the additional inconvenience that it is only for a short portion of the year that such a distinction is available at all. I am convinced that the only characteristic suitable for a basis of classification in forestry, is the bark, and that seems to have been studiously ignored by our best authorities. For my own part, while I desire to be very conservative in speaking on a subject which requires much labor and study, the more attention I devote to the oaks, the more I am inclined to believe that there is no foundation in fact for more than seven oaks in this part of the United States, viz.: white oak, black oak, red oak, Spanish oak, post oak, laurel oak, and chestnut oak. There is exceedingly small basis for a distinction between the red oak and black oak, and I question if they merit the dignity of separate species. All of the many species of our oaks, beyond these six or seven, rest, I believe, upon illusory distinctions, and can be traced through all gradations into one of the seven divisions here given. Of

course, in the following pages, the usual botanical classifications have been made, as a matter of convenience.

There is an oak found near streams, and in rich woods and glens in Kentucky, which cannot be classed, according to the distinctions now in use, as a variety of red oak, nor as a dwarf oak, nor as a *Quercus lyrata*. It resembles *Q. macrocarpa* more than any other oak, perhaps, except that the leaves are not downy or tomentose beneath; but, on the contrary, are a dark, rich, smooth green, and are shining like the leaves of *Q. lyrata*. I have called it *rich red oak*, and have classified it as *macrocarpa*.

There is another oak, called by the people chinquapin oak, and which I have classed as *Q. prinoides*, on account of its very great resemblance to chinquapin oak, but which often grows fifty feet high in the mountains of Kentucky. There is also in the mountains a low, rich green oak, the bark of which is darkish to whitish gray, with long, straight, shallow furrows at the base of the tree, growing more deep and chipped up the stem; branches smooth, gray, with brownish rough spots or dots; acorn broader than long, dorsally compressed, and one fourth buried in a brittle, scaly, flat cup. The leaf lobes are 7, 9, 11 in number, and are awned. The little tree is very rich in fruit. I have called it *Q. ilicifolia*, on account of its great resemblance to that species, though it differs from it in some respects.

TIMBER IN DETAIL.

A mere running sketch of the Purchase country and its timbers will be given here, because a special report on the timbers of this section has been prepared and published, to which the reader is referred for more detailed information. (See Report on Purchase Timbers, volume V, this series.)

In going eastward from Columbus, on the Mississippi, no timbers worthy of special mention are met with for some miles. The old forests have been cut away. About one and one quarter miles out the country is rolling, the soil white-sandy and damp, with large white oak and liriodendron

in low places, as well as black ash, black gum, sweet gum, black and red oak, pawpaw, black sumach, and redbud. Undergrowth is chiefly black oak and red oak. These timbers vary little until Bole's Creek is reached, about three miles from Columbus. On the creek are found sycamore, red elm, liriodendron, white oak, black and honey locust, sweet gum, white walnut, small black walnut, and considerable sugar maple and black ash.

Five miles out from Columbus, toward Mayfield, the forests grow heavier and more valuable, white oak forming a considerable percentage of the timbers (as much as fifty per cent. in low places), liriodendron about twelve per cent., the remainder being composed of black and pig hickory, red oak, black oak, some scarlet oak, white and red elm, sweet and black gum, and sycamore. The country is rolling, with long, damp, white-sandy levels.

About five and three quarter miles out the first swamp laurel oak, the first white maple, and the first winged elm of any size are found. On Elsey Branch, a mile further on, shag hickory and pin oak first appear—the latter very large and fine. The other timbers remain as above noted, with occasionally a fine black ash.

Eight and one half miles from Columbus one prickly ash occurs. The timbers otherwise remain without change until North Fork of Obion river is reached, eleven miles out. There the first swamp chestnut oak appears. Spanish oak also begins to grow very prominent in these forests, and to form more than one half of the upland oaks. The first post oak seen appears between North Fork of Obion river and Milburn.

Four miles beyond Milburn, toward Mayfield, the Purchase pebbles come to the surface, and a thin, dry soil, covered with post oak, scrubby black oak, &c., is the result. These pebbles are the waste of the decayed mill-stone grit, and are found in every part of the Purchase at a greater or less depth below the surface. Upon it white oak is not found; but while, as a formation, it is very dry, it brings the streams

to the surface, and along them in this locality grow the first red or water birch met with. About seven miles from Milburn, on these surface streams, pin oak is found in the greatest abundance, while post oak and black-jack crown the low, gravelly hills. An occasional spotted birch is found along the foot-hills, and considerable willow along the branches.

About eight miles from Milburn, and midway between there and Mayfield, the present "barrens" of the Purchase are entered. For a discussion of them, see the report on the Purchase timbers previously alluded to. While some of the views and the limits there expressed have been modified by later study, that is not true of the *cause* of the original barrens there given. The boundary of the present barrens, between Mayfield and Cadiz, seems to be, in this locality, Mayfield Creek; but this is not true further south, between Mayfield and Murray. I have already given reasons for believing that all the upland of the Purchase has, in former times, consisted of barrens.

On Mayfield Creek splendid cypress trees are found, associated with liriodendron, red birch, white and red elm, sweet gum, sycamore, black ash, pin oak, white oak, black gum, black hickory, &c., while in the upland forests beyond, toward Cadiz, post oak, scarlet oak, black oak, and black-jack are the principal timbers. On Panther Creek the timbers common to Mayfield Creek, with the exception of cypress, are again found. There is a marked absence also of sweet gum, for which I could assign no cause. On the hills through here grow white oak (at bases), red oak, black oak, and Spanish oak (about midway), and scarlet oak, post oak, scrub shag hickory, and black-jack (on top). The hickory here spoken of is a mountain variety of *Carya sulcata*. [The distribution of the timbers, as affected by height above drainage, will be illustrated by tables and discussed further on in this report.]

Before reaching the West Fork of Clark river, I found two chestnut bushes, about six inches in diameter, which had evidently sprung up from chestnuts dropped by passers-by. They had grown up to this size, and both had died, without

any apparent cause, except that the formation, in its *present condition*, is not adapted to chestnut growth. This matter has been previously discussed.

The timbers on West Fork of Clark river have been spoken of especially in a previous report, and do not need mention here. After passing the river the barrens continue, without interruption, except on small streams, until Wadesboro is reached and passed. The shrub spirea is found near Wadesboro. On nearing East Fork of Clark river, about one mile beyond Wadesboro, considerable good timber is found, consisting of white oak, liriodendron, white ash, black and pig hickory, Spanish, scarlet, black, and post oak, dogwood, persimmon, pawpaw, black sumach, spotted birch, sassafras, &c. On Clark river the usual swamp timbers appear in vast forests, and of the finest proportions. Sweet gum, black gum, shag and white hickory, white oak and liriodendron are especially fine.

After crossing Clark river, white oak is tolerably abundant, often extending to the hill-tops. This would seem to indicate that a *part* of the strip of country between West Fork of Clark river and Tennessee river, as well as the strip previously mentioned, between the Tennessee and Cumberland rivers, was never swept by fires to the same extent as those parts of the Purchase west of this fork of Clark river. This inference is still further strengthened by the existence of considerable chestnut all through here. It may be that the fires from the west did not penetrate across West Fork of Clark river, while those from the east found a western barrier in the Cumberland river. A fact to be mentioned presently, however, throws some doubt upon this, and leads me to believe that, at times, the fires swept across both of these streams.

About one mile from the Tennessee river we strike the *Protean* or the *Silicious group* of rocks, without any marked change in the timbers. In the Tennessee river bottom are found splendid groves of cypress, from three to seven and one half feet in diameter, nearly always standing in marshy places, in a few inches of water, with their knees reaching

up into the air. The bark on the point of these knees is always very thin. In the Tennessee bottom, in addition to the Clark river timbers, are hackberry and box-elder.

After crossing Tennessee river, there is considerable chestnut in spots, and white oak abounds on low grounds, where it does not seem that there would be much protection in case of continuous sweeping fires. Inasmuch as this white oak and chestnut are found all through between the Tennessee and Cumberland rivers, it seems very probable that the Cumberland river was a fire barrier on the east. It should be said, however, that the white oak between the rivers on upland soil is very unhealthy, and appears to be rapidly dying out, a very large proportion of the trees being already dead. The same is true of some white oaks that appear in protected spots after crossing Cumberland river. If it be true that occasional fires have crossed over and gotten between the rivers, not enough to kill out the white oak, but enough to affect the soil in such a way that white oak will not flourish on it, this decay becomes one of exceeding great interest and importance. For, in that case, the burning off of Black Mountains, now taking place regularly, will soon drive from the forests one of the finest bodies of white oak timber in the world, whether the burning be carried to sufficient extent to injure the other timbers or not.

In Trigg county, between the rivers, the first iron-wood (hop hornbeam) and the first chestnut oak are met with. A change of level, of comparatively few feet, here, is sufficient to completely change the character of the timber. Along the branches, the white oak, white hickory, shag hickory, and red oak are good, and there is considerable elm and some liriodendron, beside the usual small growth. Red birch, sycamore, laurel oak, and white oak appear in plenty on Gilbert's creek, about one and one half miles from Cumberland river.

On Cumberland river grow the most beautiful cotton trees I ever saw, reaching a diameter of four feet and a height of eighty. Sycamore, black ash, sweet gum, swamp red oak (the *macrocarpa* of Wood), swamp chestnut oak, and splendid

hickories abound, with the other swamp timbers previously noted. No chestnut is to be seen after crossing Cumberland river, and the usual upland and lowland timbers are met with in succession, without any change worthy of note, for some miles. Little River flows, at the point crossed here, over a bed of St. Louis limestone, and has scarcely any bottom or swamp soil proper, and, consequently, no swamp timbers.

After leaving Little River, the country is high, dry, and only slightly rolling, for three or four miles. The timbers are poor and valueless, with the exception of some black cherries and one hackberry found on this high level.

About six and one half miles from Cadiz, toward Hopkinsville, in a slight depression, pin oak, white hickory, black and sweet gum, sycamore, some black ash and honey locust, are to be noted. Not a white oak is to be found. The high, dry, nearly level stretch spoken of above lasts, with no surface water, until Hopkinsville is reached. There is nothing worthy of note in the timbers, except that upland and swamp laurel oak are plenty.

After passing Hopkinsville, we begin to leave the St. Louis limestone, and approach the Chester sandstone, which already caps the highest hills. Some of the timbers normally found upon it, though, are absent. The introduction of red oak, forming the larger part of the forest growth, is a marked feature in passing onto the calcareous limestone and lower Chester from the St. Louis limestone. Scarlet oaks crown the hill tops, and post oaks are found in depressions, or largely on the hill-sides *below* the Chester. The latter feature is local, however, as on a high hill, about five miles from Hopkinsville, post oaks extend up onto the Chester. The blackjack, however, is clustered around the hills just at the base of the Chester, and this I noticed to be generally true. Sugar maple, bartram oak, swamp chestnut oak, white elm, and black ash are found in considerable quantities along the streams.

For six or eight miles beyond Hopkinsville, toward Fairview, the timbers change little in kind or quality from those

just noted, except that some red haw and winged elm are found. There is no white oak, no sweet gum, no chestnut (that I could find), and no liriodendron. On Pilot Rock, northeast of Hopkinsville, which is a lofty bluff of Big Clifty sandstone, cedar and liriodendron are both met with; but this is very local, and even here no chestnut is to be seen, so far as I could gather.

Between Fairview and Elkton the timbers, as a whole, are not valuable; but in places black ash, white elm, pig and shag hickory, and such timbers, are exceedingly fine. Especially is this true on West Fork of Red river, about one and one half miles from Fairview. On this stream are also found splendid white oak, swamp chestnut oak, red and pin oak, white and shag hickory, black and blue ash, sweet gum, liriodendron, white elm, sycamore, box-elder, sugar maple, white maple, and redbud. All of these timbers are very fine. It is a peculiar, though an easily-explained fact, that in a large part of the country through here the timbers are better on the hill-tops than on the lower grounds. The reason is, that the hills are capped with Chester sandstone, the detritus of which forms a damp soil, favorable for large trees, while the upper St. Louis limestone here is not adapted to timber growth.

Toward Elkton, scattering bartram oaks and cedars are found, in addition to the usual red oak, shag hickory, pig hickory, white hickory, winged elm, small black ash, scrub white oak (in spots), Spanish oak, black oak, post oak, black gum, &c. Yellow wood is also found near Elkton, with some honey locust, redbud, and red (slippery) elm. Of course the swamp timbers have never been affected by fire; and on streams fine white oak, liriodendron, white and sugar maples, sweet gum, laurel oaks, &c., flourish. The upland and low-land timbers alternate, with no changes worthy of note, until Russellville is reached—and there our party took the train and went by rail to Glasgow Junction.

Between Glasgow Junction and Mammoth Cave the topography is very different from that spoken of in the previous pages. There is no well-defined succession of hills and hol-

lows, the result of erosion, through the latter of which the streams of the country flow. The formation is a cavernous Saint Louis limestone, the roofs of whose caverns have given way in many places and let the surface of the ground fall in, forming regular sink-holes, more or less circular in form, often of the dimensions of wide and deep hollows, but with no outlets. There are no surface streams, and into these sink-holes the surface water flows, and the detritus washes and accumulates. It is natural to expect in such places the most splendid timbers, and such are often found there.

Again, forest fires have evidently not denuded certain parts of the country in the neighborhood of Mammoth Cave. What is known as Doyle's Valley, for instance, has been, for some reason, largely protected from the ravages of fire, even if the entire district has not been. From the growth of chestnut, I am inclined to think that it has never been continuously burned over.

On leaving Glasgow Junction, toward Mammoth Cave, plenty of white oak is found in the sinks; post oak, black oak, scarlet oak, and red oak are found on the higher grounds, and as soon as Chester sandstone, which caps the so-called hills, is reached, chestnut is found in great abundance. This is the first chestnut worthy of note found, and all that has been found, so far, if a few bushes on the silicious limestone, near Tennessee river, be excepted; though doubtless all this Chester sandstone, from Hopkinsville to Glasgow Junction, would have been covered with it, but for the fires that long ago swept over this richly timbered country, year after year, and drove its choicest trees from the forests.

On the hill sides facing Doyle's Valley the trees are magnificent, and white oak, liriodendron, white hickory, massive chestnut, scarlet oak, red oak, black oak, Spanish oak, chestnut, ashes, redbud, &c., abound. The chestnut, however, is limited to the sandstone, and stops abruptly when the limestone is reached in descending the hill.

On nearing Mammoth Cave, and all along the banks and cliffs of Green river, hornbeam (*Carpinus Americana*, often called iron-wood, but not the true iron-wood) and hop horn-

beam (true iron-wood) abound. On the long, high level above the cave the principal timbers are red, black, and Spanish oak. They are worthless except for fire-wood.

In the immediate vicinity of Mammoth Cave, and crowning the hill-side facing Green river, above and below it, the timbers are red oak, liriodendron, chestnut (on sandstone or its detritus), white hickory, white oak, black walnut, blue ash, an occasional sugar and rock maple, winged elm, &c. At the base of the hill, on Green river, are beeches, sycamores, spice-wood (the first met with), white hickory, liriodendron, and white oak. Black sumach, woodland huckleberry, buckeye, dogwood, &c., are among the small growths.

About two miles from Mammoth Cave, toward Cave City, the hill-tops are poor, and are covered with Spanish oak, scarlet oak, black-jack, and an occasional mountain oak. In the sink-holes and on their steep sides grow splendid chestnut, pig and white hickory, liriodendron, some white oak, post oak, and black locust. The chestnut is found only on the sandstone. These upland and lowland timbers alternate, without any changes worthy of note, except occasional swamp chestnut oaks, Bartram oaks, laurel oaks, and black hickory, until we begin to pass into the present eastern barrens, about twelve miles from Cave City, and within about eighteen miles of Greensburg. White oak and chestnut cease to exist, except the former on streams, &c., and a repetition of the barren timbers of the Purchase occurs. There seems to e a neck of country about Mammoth Cave which has, for some reason, more or less escaped the ravages of fires.

Nothing else of interest occurs until we begin to pass from the cavernous St. Louis limestone onto the Keokuk limestone, sixteen or eighteen miles from Cave City. The change of formation first attracts attention by the circular sinks beginning to fade away into valleys, and the steep cave-hills into the more gently-rolling ones, due to erosion. The normal hill and valley topography gradually succeeds again the wonderful cavernous district, of which Mammoth Cave is the most widely known, if not the most interesting and instructive part.

The Keokuk is an exceedingly fertile formation, and its timbers are nearly always, on the limestone, of the finest. Its soils are rich in marls, it furnishes a good supply of surface water, and has all the requisites for the production of splendid forests. Timbers, therefore, grow better and more valuable at once on passing onto the Keokuk; but white oak, chestnut, and most of the liriodendron, have been driven from the forests in this locality by fire. With these exceptions, the hill-side facing Little Barren river on the west furnishes a good sample of the timbers that grow on the Keokuk limestone. They are black cherry, black locust, swamp chestnut oak, black walnut, some liriodendron, white and shag hickory, sycamore, mulberry, blue ash, red elm, white maple, redbud, water beech, hackberry, and cedar. On the same formation, immediately after crossing Little Barren river, plenty of chestnut and white oak are found, with scarlet oak, black oak, pig hickory, and sugar maple, in addition to the timbers just mentioned above; and all through the hills white oak, chestnut, and liriodendron become exceedingly fine and valuable. This points to the probability that Little Barren river was the eastern barrier to the ancient fires.

On nearing Green river, about five and one half miles from Greensburg, the forests are magnificent. They consist of large liriodendron, white oak, shag hickory, white hickory, black walnut, beeches, swamp (rich) red oak, hackberry, honey locust, red elm, box-elder, blue ash, sugar maple, water beech, and swamp chestnut oak. In the swamp, in addition to these, are black locust, big buckeye, and black ash.

After crossing Green river, we ascend again onto a somewhat sharply-rolling country, whose bed-rock is very much decayed St. Louis chert, and whose timbers, for several miles, are nearly altogether beeches. This peculiar beech growth, occupying alike the highest hills and the lowest grounds, has already been spoken of.

About five and one half miles from Greensburg, toward Campbellsville, the beeches begin to give way to black oak, red oak, liriodendron, chestnut, pig and black hickory, swamp

chestnut oak, white oak, blue ash, &c.; and within about three miles of Campbellsville white oak forms as much as fifty per cent. of the splendid forests. Scattered through the woods are also found white walnut, tree of Paradise, fine black walnut, black cherry, iron-wood, shrub buckeye, big buckeye, red-bud, sassafras, dogwood, red oak, Spanish oak, scarlet oak, chestnut, red haw, black sumach, and pith elder. The entire absence of sweet gum, even from the swamps, all through the country, from the Cumberland river eastward, will have been noticed. I could find no satisfactory reason for it.

A long, dry shale level, covered principally with black, Spanish, and scarlet oak and black hickory, begins within about nine miles of Mansville (Buena Vista). Occasionally the shale is cut across by small streams, and in the depressions white oak, laurel oak, water beech, winged elm, spotted birch, and some chestnut are found. In some of these depressions, where the shale is always moist, the forests are very heavy, and white oak, chestnut, liriodendron, pig and white hickory, black and Spanish oak, &c., abound. About three miles from Mansville, post oak and sweet gum are met with again.

At Mansville, on Robinson's Creek, we pass onto Devonian shale, and the timbers become nearly worthless, except on streams where the usual lowland timbers are found.

About three miles beyond Mansville, toward Stanford, there is a small belt of country, less than half mile in breadth, on which thirty per cent. of the undergrowth is white oak. I have seen only two or three other spots in the State where any considerable proportion of the bushes consists of that timber. The tops of the hills in this locality are covered with post oak, scrub black oak, huckleberry, &c.; and the first mountain chestnut oak seen east of the Cumberland river is here found. Pith elder and black sumach inhabit the fence-rows, with occasionally a shrub buckeye, some bushes of winged elm, &c. The hills, in a wholly Devonian shale formation, are always low, and their timber growth is comparatively worthless, such as scarlet oak, post oak, Spanish oak, scrub

black oak, and scrub hickory. On low grounds considerable white oak, pig hickory, and winged elm are found, but they are not valuable.

About five and one half miles from Mansville, we pass from the Devonian shale onto the underlying Corniferous limestone, of which there is a layer of only three to five feet in thickness in this locality. Underlying this again is the so-called Cumberland sandstone, a bluish, silicious, almost semi-limestone formation. The only immediate change of timber noticed was the introduction of a few swamp chestnut oaks, and their presence cannot be attributed merely to change of formation. Some white and sugar maples appear on low grounds, with sweet and black gum, white oak, red oak, and iron-wood.

On the Cumberland sandstone liriodendron again becomes a conspicuous timber, and the forests become much better in every way. On a large hill, about seven miles from Mansville, the woods are exceedingly rich. The principal timbers are blue ash, Ohio buckeye, black walnut, white and shag hickory, liriodendron, and white oak. Big buckeye forms from forty to seventy-five per cent. of the timbers in this rich forest. On the eastern face of this chain of hills, not far above its base, and about ten miles from Mansville, we pass onto the Cincinnati limestone. The timbers do not vary in kind from those given above, and there are no changes for several miles, except that occasionally a hackberry or an aspen is seen.

Taken as a whole, the standing forests are poor and valueless all along South Rolling Fork. The formation alternates between Cumberland sandstone and Cincinnati limestone—first up onto the former, then down onto the latter, and so on. All through the valleys the timbers have been cut away, and on the hills they are worthless.

At about six miles south of Hustonville (twenty miles from Mansville), there is the largest forest of bartram oak I know of in Kentucky. The valuable timbers are all cut away, on low and high grounds alike. The standing forests are worthless, and are likely to remain so, unless a thrifty cultivation and protection soon succeed the long-continued destruction.

At about two miles south of Hustonville the Cumberland sandstone dwindles away to a shaly bed about ten feet in thickness, overlaid by heavy deposits of Corniferous; and in starting through "Nigh Gap," it gives out altogether, and the overlying Corniferous rests directly upon the underlying Cincinnati limestone. "Nigh Gap" is the passage-way over Muldraugh's Hill, starting from Rolling Fork. The base of the hill here is Devonian shale, which is succeeded by Keokuk limestone at a height of seventy-five barometric feet. The transition presents a marvelous change in the timbers, and brings into strong contrast the difference between these two geological formations, in their effects upon forest growths. On the shale the timbers are mountain chestnut oak, scrub white oak, sour-wood, red oak, a few beeches (right on the river), some rock maple, &c. On the Keokuk, immediately adjoining, and on a higher level, grow splendid forests of white oak, black hickory, chestnut, black locust, liriodendron, white and shag hickory, sugar maple, redbud, spicewood, mulberry, blue ash, black ash, black cherry, American linden or basswood (the first met with), black walnut, red haw, and the usual small growth. The exceeding variety and richness of these Keokuk timbers is worthy of note. As to the questions pertaining to distribution, as affected by height above drainage, they become of the first importance from this point eastward, and will be discussed and illustrated under a separate head further on in this report.

After crossing Muldraugh's Hill, we enter the counties (north part of Lincoln and Garrard) the forests of which have been almost completely cut away. There are only scattering patches of fenced-in groves, consisting mostly of black and blue ash, white oak, black walnut, pig and shag hickory, and hackberry, until Muldraugh's Hill is reached again, near Big Hill, in the southern part of Madison county. The geological changes are numerous. Stanford rests on Cincinnati limestone, and this continues to be the formation in depressions for some distance. On the higher grounds Cincinnati (?) sandstone appears. Between Paint Lick and Irvine, and

about twenty-nine miles from the latter place, we pass from Cincinnati up through about ten feet of Corniferous onto Devonian shale. Hackberry is found scattered all through the country.

About twenty-seven miles from Irvine the formation is still Devonian shale; but its detritus forms a long, whitish level, on which, in choice local spots, considerable white oak is found. Timbers are chiefly poor and valueless.

We strike the Corniferous again near Silver Creek, about two miles west of what is locally known as Johnson's Shop; but we pass onto Devonian shale again on Silver Creek. Pawpaw bushes, black sumach, and scrub buckeye are found in the greatest abundance all through here, together with some laurel oak and post oak. The valuable timbers have all been cut out.

Near Big Hill, while Devonian shale is still the lowland formation, Waverly (Keokuk) shales are the foot-hill formation. The tops of the high hills, such as Big Hill and Buzzard's Basin, are capped with Conglomerate; so that we have a complete geological section, from Devonian shale to Conglomerate, on one of these hills. Here the first pines (*pinus mitis*) are met with on the journey eastward. They crown Big Hill and other high points, and are found on the dry, thin shales of the foot-hills.

After leaving Big Hill post-office, toward Irvine, on Red Lick Fork, red birch, holly (the first noted), sweet gum, white oak, Spanish oak, red elm, spotted birch, service berry (*Amelanchier*), laurel oak, black ash, willow, red oak, cedar, shag hickory, sugar maple, buckeye, pine, box-elder, redbud, black gum, pawpaw, and sour-wood are met with. A large part of the valley timbers is still cut away. Some American linden is found on the high knobs between Big Hill and Irvine, associated with fine black walnut, white oak, white hickory, and liriodendron, about the heads of the numerous little branches that flow from the hill sides. The timbers remain without essential change to Estill Springs.

After passing Irvine, and turning up the Kentucky river toward Beattyville, the formation is successively Devonian (on lower spots) and Waverly (chiefly cortigalli). The forests for some miles are not very valuable. A low, dark green, exceedingly fertile mountain oak (*Quercus ilicifolia?*) appears in great abundance on the hill-sides, and about five miles from Irvine hemlock is first seen. Fine pig hickory, white oak, Spanish oak, red oak, blue ash, green ash (only one), sugar maple, buckeye, liriodendron, white hickory, and red elm are scattered all along the river and mountain sides. The timbers remain pretty much the same for three or four miles, when the first magnolias (cucumber trees) are met with. Associated with them are Ohio buckeye, black ash, redbud, winged elm, liriodendron, white maple; water beech, green dogwood, amelanchier, rhododendron, and kalmia (the first of these laurels found), red elm, spotted birch, red oak, mulberry, white oak, walnut, cedar, red sumach, and pawpaw. The formation is Keokuk.

All of the hill-sides near Irvine are covered with splendid forests of black and blue ash, pig, shag, and white hickory, liriodendron, sugar maple, white oak, bartram oak, sycamore (on streams), box-elder, red elm, some American linden, magnolias (*cucumber* and *Frazeri*), red birch, mulberry, sweet gum, big buckeye, and catalpa.

About fourteen miles from Irvine, toward Beattyville, the river valley contracts and becomes very narrow, the hills close in on all sides, and we pass through a deep ravine, the escape from which is over what is widely known, locally, as the "Winding Stairs." In ascending the Winding Stairs, the following timbers are found: linden, black and blue ash, rich red oak, chestnut, white oak, liriodendron, white maple, white and black walnut, white hickory, pig hickory, magnolias (umbrella and cucumber), black birch, black gum, water beech, dogwood, mountain chestnut oak, spicewood, willows (near a spring), rhododendron, kalmia, azalea (*nudiflora* and *viscosa?*), Amelanchier (two varieties), pines (*mitis* and *rigida*), black oak, scarlet oak, black sumach, sassafras, and dog-

wood. The chestnuts begin as soon as Chester sandstone is reached, in ascending the hill. The timbers here given are nothing more than a fair average, and all of them may be found on any high hill in this part of the State.

After reaching the top of the Winding Stairs, there stretches out a long, irregularly level expanse of country, on which the timbers are not worth special mention. From this level the road descends to Lower Stufflebean Creek, about two and one half miles from Beattyville. The formation is Sub conglomerate shale, varying into Conglomerate sandstone. The timbers are not noteworthy, except that holly and swamp alder appear in considerable quantities.

For several miles beyond Beattyville, toward Jackson, no great changes in the forests occur, and the timbers are such as are usually met with on the lowlands. We follow the Kentucky river tolerably closely for a considerable distance. About three and one half miles from Beattyville, along the river bank, grow perfect thickets of pawpaws, which often reach a height of fifty feet! With them, and along the foothills, grow red and white elm, sycamore, black and blue ash, linden, big buckeye, water and common beech, liriodendron, hemlock, swamp alder, pith elder, red oak, iron-wood, amelanchier, sweet gum, golden alexander, red and black haw, and hawthorn. On the higher hills are post oak, black oak, red oak, scarlet oak, mountain oak, black locust, and the usual hill timbers. About five miles from Beattyville the forests of white oak are as fine, along the rich hill-sides, as I ever saw. Hickories are splendid also, and walnut, liriodendron, chestnut (on sandstone formations), and linden are unsurpassed along all the ravines whose waters head in the rich woods below the brows of the high hills. The tops of the hills are crowned with black oak, scarlet oak, mountain chestnut oak, rock maple, scrub hickories, and pines.

The splendid timbers given above continue, with only local breaks, all along Lower and Upper Twin Creeks, and the hills through which they flow. The latter stream empties into Middle Fork of Kentucky river, within about twelve or thir-

teen miles of Jackson, Breathitt county; and at its mouth the road leaves the river and turns up it, follows it to its head, crosses the divide at its head waters, and descends onto West Fork of Cane Creek, down which it follows toward North Fork of Kentucky river. The timbers all through these high, abrupt, and inaccessible hills, and deep, rich, ravine-like hollows, are scarcely surpassed in the State. A considerable amount of fine old forest walnut, black birch, and cherry still stand in these fastnesses, and gigantic liriodendrons, white oaks, ashes, lindens, locusts, chestnuts, elms, buckeyes, magnolias, and maples have, so far, bid defiance to the axes that have laid these timbers waste in other parts of the State. Civilization has not yet penetrated into these forest wilds, and the grandeur of the trees and the silence of the woods make a striking impression upon one.

The tall, dark, rich-green oak spoken of heretofore, and which I have called *rich red oak*, flourishes all through these woods. It is probably the *macrocarpa* of the botanies. A few hackberries, considerable gray birch, some white pine, &c., are met with.

High up on Upper Twin Creek, about seven miles from Jackson, on a hill-side facing north and east, at a barometric height of thirty-five feet above the small stream below, a rich belt of black walnut trees encircles the hill. There are not a great many trees in the belt, but some of them are exceedingly fine. Beds of coal are found along Upper Twin Creek, and the formation is coal-measure sandstone. All through the woods there is found, in great abundance, a hickory which I have called *microcarpa*, because it is evidently a variety of the "white hickory" of former reports on Kentucky timbers. It is a tall, clean-trunked, fine-bodied tree, branching high; bark comparatively thin, nearly smooth right at base, where the shallow interspaces of the bark are nearly straight, or only slightly chipped, but considerably more chipped higher up the trunk; leaves linear, acute at base, lance-tipped, serrate and smooth, except slightly downy at base of veins.

From Jackson to the mouth of Troublesome Creek, seven miles out toward Hazard, we pass right along North Fork of Kentucky river, with the usual lowland timbers along the river, and no changes of moment on the hills. Our route now lay up Troublesome Creek to Lost Creek; up Lost Creek to its head waters, across the divide onto Lot's Creek, and thence to Hazard. The hill timbers along this course are very similar to those already given on Twin Creek, and the forests are everywhere of the finest. The question of distribution, as affected by height above drainage, which is the most important one that presents itself in this part of the State, will be, as I have previously said, illustrated and discussed separately.

A list of the timbers noted in the Troublesome Creek region, includes white, black, and pig hickory, white oak, holly, black and blue ash, white ash, black walnut, liriodendron, chestnut, black gum, black and gray birch, winged elm, white, rock, black and mountain maple, redbud, mulberry, red oak, black oak, mountain chestnut oak, scarlet oak, beeches, black cherry, hawthorn, red haw, big buckeye, black locust, linden, water beech, silver poplar, cucumber and umbrella trees, swamp chestnut oak, sycamore, bartram oak, scrub red oak, magnolia (*Frazeri*), pines, cedar, hemlock, elm (*racemosa*), American laurels (rhododendron and kalmia), spicewood, papaw, pith elder, willows, persimmon, dogwood (green and low cornel), black sumach, and swamp alder. The *scrub red oak* is probably the *ilicifolia* of the botanies. The great variety, and the richness in valuable timbers, of these forests, I think, can scarcely be surpassed. The formation is coal-measure sandstone.

The timbers above given are found, with local variations and alternations, until North Fork of Kentucky river is reached again at Hazard. The usual swamp timbers are there found, and, in addition to them, hazelnut, aspen, and Solomon's seal.

After passing Hazard, the road follows North Fork of Kentucky river about six and one half miles, to the mouth of

Carr's Fork. It then turns up that stream, follows it for about ten miles, crosses over the divide onto Rockhouse Creek, and strikes the Kentucky river again at Whitesburg, thirty-five miles from Hazard. The upland and lowland timbers between these two places are precisely the same, with the addition of wintergreen and white willow (*Salix candida*), as those given in the Troublesome Creek region. The old forest walnut is scarce; but it is exceedingly large, and of good quality, on the heads of most of the streams, far up under the brows of the high hills. White linden and ironwood are found. The former has not been met with previously, but it abounds on the mountains to the southwest.

In about ten miles of Whitesburg quite a marked change in the distribution of the hill timbers occurs. The formation remains coal-measure sandstone; but the surface soils of the hills are a thin, whitish shale detritus, very poor, and there are no damp, dark, rich hill-sides, covered with splendid lowland timbers nearly to the top. The swamp timbers are narrowly confined to the margins of the streams and to the bottoms. In other words, the line of comparative moisture, if such line be imagined, has been removed down the hills; so that, to find a belt of given moisture, one would have to look much nearer the bases of the hills. A corresponding effect is, of course, produced upon the timbers.

In passing over the divide between the head waters of Kolley's Branch and Sandy Lick, within about seven miles of Whitesburg, the road circles around the head of a branch which flows from a deep ravine to the left (northeast) of the road. Just above the head waters of this branch, on the steep hill-side, grow some of the finest liriodendron and black walnut trees I have seen in Kentucky. One of the former reaches the enormous size of eighty inches in diameter, with fifty feet of clear, straight trunk. The walnuts are thirty-eight to forty inches, with fifty to sixty-five feet of beautiful body. White oak, white and pig hickory, buckeye, and other timbers, are proportionately good and valuable. A few "burning bushes" (*Euonymus Americana*) are also found. The formation is coal measures.

At Whitesburg the North Fork of Kentucky river is reached again, and for some distance beyond the road follows the river pretty closely. The usual lowland timbers, of which lists have been given, are met with. A great deal of sweet gum is found in localities, especially about five miles from Whitesburg. The hills near the river are largely covered with poor sandstone shale, and the timbers are not very good. At a distance from the river, however, the hills are richer, and the forests are very valuable. Considerable white walnut and black birch are found all through the woods. Otherwise, the timbers remain comparatively unchanged, until the head waters of North Fork of Kentucky river are reached, at the base of the mountain below Pound Gap.

On the mountain sides near Pound Gap and along the dark, rich ravines, stately and beautiful walnut, linden (American and white), black birch, black cherry, white oak, liriodendron, hickories, and most of the valuable forest timbers of the State, flourish in the greatest abundance. The ancient forests stand unharmed by the ax, and are likely so to remain for some years to come.

About three quarters of a mile from Pound Gap, the road crosses the Pine Mountain fault, and we pass at once from the coal measures to Devonian shale. The shale is only a narrow strip, however, and we are soon on the overlying Keokuk, and, inasmuch as that is one of the richest timber-producing formations in the State, growing alike the timbers of the limestones and those of the sandstones, the splendor of the forests is only slightly interrupted. When I speak of the Keokuk being one of the richest timber-producing formations known, I have reference to the Keokuk limestones of the East, for the Waverly shales are among the poorest of all formations—as dry, thin, and unproductive as the Devonian shales.

The observer will notice, all through this part of Pine Mountain, that there are two belts of pine trees. The mountain

pine (*P. pungens*) and the pitch pine (*P. rigida*) are found on the dry, sandy bluffs and tops of the mountains; the long-leafed pine (*P. palustris*) and the yellow pine extend further down on the mountain slopes.

At Pound Gap we pass across from Kentucky into Virginia, and at the base of the mountain, on the Virginia side, flows Pound Creek. We follow this stream to Indian Creek, thence turn up Indian Creek to its head waters and across to Gladesville. As soon as we pass Pine Mountain into Virginia, the hill-sides are covered with chinquapin (*Castanea pumila*), not one of which has, so far as I could discover, crossed the mountain northward. The chinquapins do not extend up nearly to the top of Pine Mountain, and evidently the climate is too cold for them, and this mountain is their northern boundary. They are found in the greatest abundance all through the woods of Virginia, and southward.

The magnolias begin to die out after crossing Pine Mountain, though a few are found along shady ravines and on rich hill-sides in Virginia. The coal measures reappear again at a short distance from Pound Gap, on the Virginia side, and thence we pass onto the Conglomerate, which lasts nearly to Clinch river. There a fault of ten thousand feet, running along the line of Clinch river, brings up abruptly the Knox limestone, and between there and Abingdon, Virginia, a succession of faults causes an almost constant alternation of the Cincinnati and Knox limestones. The forest timbers are not, upon the whole, so good as are those on the north side of Pine Mountain, in Kentucky; but they are everywhere valuable, and there is no marked difference in kind, other than those noticed.

TIMBER DISTRIBUTION AS AFFECTED BY HEIGHT ABOVE DRAINAGE.

Although the data for this report have been prepared with special reference to a discussion of the effects of height above drainage upon timber growth, and, with that object in view, the following tables have been arranged, nevertheless it is necessary to point out some of the dangers of generalizing

from such data, and especially some of those disturbing elements which render investigation in this particular direction liable to error. The first, and probably the most important, of these is sudden and abrupt changes in the nature and relative hardness of different parts of the same formation. In fact, to this cause is due, almost altogether in *hills*, and very largely in *mountains*, height above drainage itself; but it is in a narrower sense that it becomes a disturbing element in discussing timber growth. The sudden cliffs and benches on hills and mountains are caused by difference in hardness of two successive strata; and a cliff of exceedingly hard rock, or hard, dry soil, even when near the base of a hill, will often be permanently drier than a bench or hill-top barometrically much higher above drainage. The hardness of such a cliff prevents the formation of detritus and the retention of water For this reason a softer formation or bench, easily worn away, and capable of forming a surface detritus which will retain moisture, is, so far as effect upon timber growth is concerned, nearer to water than a hard cliff hundreds of feet below it.

Another disturbing element is sudden change in geological formation. One of the dry shales, like the Devonian and some of the Waverly shales, will cause as much change in timber growth as would be produced by the greatest height above drainage attainable in our mountains. Of course the change might be different in character, but in amount it would be as great. Changes of this nature, though, can usually be guarded against in gathering data.

The natural difference in shade, moisture and coldness, between the northern and the southern faces of hills, also produces its effect upon the timber growth. All of these disturbing elements have been taken into consideration, and accounted for, as far as possible, in preparing the following tables. The liability to slight error, however, should be kept in view.

In the tables, "N. F.," "S. F.," &c., under the barometric height at the head, mean, respectively, "North Face," "South Face," &c., of the hill.

TABLE No. 1.

Barometric height.	Location.	Formation.	Timbers.
1350 feet.	Foot-hill in Trigg county, about one mile from Tennessee river.	Silicious Limestone.	White oak (fifty per cent. of timbers), red oak, black oak, black and pig hickory, iron-wood, black gum, dogwood, and Spanish oak.
1390 feet.	Same on hill-side.	Same.	Black oak (sixty per cent. of timbers), Spanish oak, pig hickory, black hickory, and scrub oak.
1400 feet.	Same.	Same.	Same, with mountain chestnut oak.
1410 feet.	Same.	Same.	Same, with post oak and some chestnut.
1460 feet.	Bench of hill.	Same.	Mountain chestnut oak (forty per cent. of timbers), black oak, scarlet oak, post oak, and chestnut (only one).
1485 feet.	Hill-top.	Same.	Black-jack, mountain chestnut oak, and scrub black oak.

TABLE No. 2.

Barometric height.	Location.	Formation.	Timbers.
1290 feet. (E. F.)	Foot-hill four miles from Tennessee river.	Silicious Limestone.	Sweet gum, white elm, white oak, rich red oak, pig hickory, and white hickory.
1375 feet.	Hill-side.	Same.	White oak, rich red oak, black hickory, and pig hickory. Sweet gum and elm have given out.
1430 feet.	Same.	Same.	White oak, pig, shag, and white hickory end. Post oak, black oak, and Spanish oak begin.
1475 feet.	Hill-top.	Same.	Black-jack, scrub Spanish oak, post oak, and scarlet oak.

TABLE No. 3.

Barometric height.	Location.	Formation.	Timbers.
1375 feet. (W. F.)	Foot-hill 3½ miles from Cumberland river.	Saint Louis Limestone.	Liriodendron, white oak, red oak (one only), sweet gum, sugar maple, and red maple.
1450 feet.	Hill-side.	Same.	Liriodendron, black oak, pig and black hickory, and red maple. Sweet gum, white oak, and sugar maple have disappeared.
1495 feet.	Bench of hill.	Same.	Scarlet oak, black oak, post oak, and black-jack.
1538 feet.	Hill-top.	Same.	Post oak and black-jack.

TABLE No. 4.

Barometric height.	Location.	Formation.	Timbers.
1315 feet.	Base of small hill of representative timbers, 5½ miles from Hopkinsville.	Calcareous Limestone.	Bartram oak, swamp laurel oak, pig hickory, post oak, and red haw.
1325 feet.	Hill-side.	Same.	Post oak, pig hickory, black oak, scarlet oak, black-jack, and upland laurel oak.
1350 feet.	Same.	Beginning of Chester Sandstone.	Black oak, scarlet oak, Spanish oak, pig hickory, and black hickory.
1390 feet.	Hill-top.	Chester Sandstone.	Scarlet oak, post oak, black oak, and Spanish oak, predominating in order given.

TABLE No. 5.

Barometric height.	Location.	Formation.	Timbers.
1452 ft. (S. W. F.)	Foot-hill two miles from Elkton.	St. Louis Limestone.	White oak, red oak, pig and shag hickory, white and winged elm, bartram oak, yellow wood, and red oak.
1520 feet.	Hill-side.	Same.	Post oak, blue ash, redbud, yellow wood, and hickories.
1540 feet.	Hill-side.	Same.	Same, except hickories end, and black-jack begins.
1560 feet.	Hill-side.	Top of St. Louis Limestone.	Hickories, post oak, and black-jack on Sandstone. (Note.—Reappearance of hickories on Sandstone.)
1625 feet.	Hill-top.	Chester Sandstone.	White oak (one), black oak, hickory, and black-jack.

TABLE No. 6.

920 feet.	Foot of average hill, ten and three fourths miles from Greensburg.	Upper Keokuk and Lower St. Louis Limestones.	Splendid white oak, liriodendron, pig hickory and white hickory.
970 feet.	Hill-side.	St. Louis Limestone.	Same, except hickories and liriodendron end, and scarlet oak and black oak begin.
1050 feet.	Hill-side.	Damp, rotten St. Louis Chert.	White oak, chestnut, black oak, red oak, and scarlet oak.
1070 feet.	Hill-top.	Same.	Same, with Spanish oak.

TABLE No. 7.

Barometric height.	Location.	Formation.	Timbers.
1120 feet. (S. F.)	Knob about 9 miles from Mansville —base.	Cincinnati Limestone.	Splendid liriodendron, white oak, rich red oak, blue ash, black walnut, white and shag hickory, sweet gum, and buckeye.
1138 feet.	Hill-side.	Cumberland Sandstone begins.	Same, except sweet gum ends.
1240 feet.	Hill-side.	Devonian Shale begins.	White oak, black oak, red oak, mountain chestnut oak, pig hickory, mountain maple, and spicewood—all on top of Cumberland Sandstone.
1285 feet.	Hill-side.	Devonian Shale.	Scarlet oak (very large percentage), post oak, black-jack, huckleberry, and dogwood.
1380 feet.	Hill-side.	Top of Shale bluff.	Mountain chestnut oak, scattering scrub black oak, scarlet oak, and huckleberry.
1450 feet.	Hill-top.	Steep bluff, Keokuk Limestone.	Scrub post oak, mountain chestnut oak, winged elm, redbud. spicewood, and azalea.

TABLE No. 8.

1575 ft. (N. W. F.)	Base of Muldraugh's Hill, on Rolling Fork.	Devonian Shale, with Corniferous, right in creek.	Mountain chestnut oak, beech, red oak, sour-wood, scrub white oak, and mountain maple.
1640 feet.	Hill-side.	Beginning of Keokuk Limestone.	Magnificent white oak, chestnut, liriodendron, black oak, black hickory, white hickory, ash, black locust, &c. (Note.—Great change in timbers in passing onto Keokuk.)
1675 feet.	Hill-side.	Keokuk Limestone.	Splendid liriodendron, chestnut, white and shag hickory, redbud, sugar maple, spicewood, and mulberry.
1700 feet.	Hill-side.	Keokuk Limestone.	Same as last, and black and blue ash, linden, black cherry, black walnut, hawthorn, red oak, and amelanchier.
1735 feet.	Hill-side.	Thin Waverly or upper Keokuk Shale.	Mountain chestnut oak, black oak, red oak, pig hickory, and iron-wood.
1810 feet.	Hill-top.	. . . . .	Mountain chestnut oak, scrub black hickory, blue ash (one), small red oak, and azalea. (Note.—The breaking of our mercurial barometer prevented the preparation of further data until Irvine was reached.)

TABLE No. 9.

Barometric height.	Location.	Formation.	Timbers.
1290 feet. (N. F)	Base of Estill Springs Knob.	Devonian Shale.	White oak, pin oak, black gum, and honey locust. No small growth.
1350 feet.	Hill-side.	Same, with detritus of Cortigalli Sandstone.	White oak, liriodendron, red oak, water beech, sour-wood, and pine (*mitis*).
1385 feet.	Bench.	Top of Devonian Shale.	On the Shale bench only pine, dwarf red oak, and post oak.
1420 feet.	Saddle of bench.	Cortigalli Sandstone.	White oak, Spanish oak, scarlet oak, white maple, huckleberry, and sour-wood.
1465 feet.	Hill-side.	Same.	Mountain chestnut oak, scarlet oak, white maple, huckelberry, and black sumach
1580 feet.	Same.	Same, with heavy detritus.	Very heavy undergrowth of hickory, black oak, redbud, and dogwood. Old trees are white oak and black oak.
1685 feet.	Same.	Cortigalli bluff.	Mountain chestnut oak, mountain maple, redbud, sour-wood, and dogwood.
1720 feet.	Same.	Cortigalli.	Mountain chestnut oak, shrub white hickory, winged elm, dogwood, &c.
1785 feet.	Hill-top.	Same.	Mountain oak, scrub hickory, scarlet oak, redbud, scrub elm, huckleberry, and pine (*mitis*). Pines and white sumach almost exclusively occupy the south face of the Knob.

TABLE No. 10.

Barometric height.	Location.	Formation.	Timbers.
1300 feet.	Base of "Winding Stairs," 14 miles from Irvine.	Keokuk Limestone	Swamp chestnut oak, white oak, white and shag hickory, liriodendron, black ash, rich red oak, sycamore, box-elder, red elm, buckeye, sugar maple, American linden, magnolias (cucumber and Frazeri), mulberry, sweet gum, red birch, and catalpa.
1480 feet.	Hill-side—base of bluff.	Base of St. Louis Limestone.	Up to this bluff, last timbers flourish. Fine belt of linden at this height.
1535 feet.	Bench of hill.	St. Louis Limestone	All foot-hill timbers are found on this bench, as it is the *spring level*, and the ground is very moist Spicewood and willow are also found.
1575 feet.	Bench of hill.	Base of Chester Sandstone.	Splendid chestnut, white oak, liriodendron, white and pig hickory, umbrella tree, black and blue ash, water beech, dogwood, &c. (NOTE.—Appearance of chestnut on Sandstone)
1700 feet.	Bench of hill.	Base of Conglomerate Sandstone.	Chestnut, liriodendron, black beech, white hickory, linden, black gum, water beech, mountain chestnut oak, and dogwood.
1750 feet.	Hill-side.	Conglomerate Sandstone.	Chestnut, mountain maple, mountain chestnut oak, black gum, water beech, dogwood, rhododendron, and azalea.
1800 feet.	Hill-side.	Same.	Thicket of Kalmia (latifolia), rhododendron (max.), with chestnut oak, mountain maple, water beech, sour-wood, huckleberry, amelanchier and azalea.
1820 feet.	Hill side.	Same.	Pine begins. Other timbers same as last.
1900 feet.	Hill-top.	Same.	Pine, scarlet oak, scrub black oak, dogwood, sour-wood, black sumach, sassafras and huckleberry.

TABLE No. 11.

Barometric height.	Location.	Formation.	Timbers.
1460 feet.	Base of characteristic low hill, six miles from Beattyville.	Conglomerate Sandstone, with underlying Shale	Splendid white oak, liriodendron, black hickory, black ash, rich red oak, water beech, redbud, red maple, and dogwood.
1490 feet.	Hill-side.	Conglomerate Sandstone.	Belt of white hickory. Other timbers unchanged, except black ash and rich red oak have given out.
1520 feet.	Hill-side.	Same.	Spanish oak, black oak, black hickory, scrub white hickory, and scattering white oaks.
1545 feet.	Hill-top.	Same.	Spanish oak, scarlet oak, sour-wood, and dogwood.

TABLE No. 12.

1405 feet (N. F.)	Base of hill, fifteen miles from Jackson.	Coal-measure Sandstone.	White oak, beech, chestnut, white maple, dogwood, black oak, red oak, and amelanchier.
1470 feet.	Bench of hill.	Same.	Splendid white oak, beech, water beech, hickory, green cornel, and black gum.
1510 feet.	Hill-side.	Same.	White oak ends. Mountain chestnut oak, water beech, mountain maple, black gum, dogwood, amelanchier, and sassafras.
1605 feet.	Level hill-top.	Same.	White oak, red oak, water beech (what a misnomer!), sour-wood, dogwood, and amelanchier. (Note.—Reappearance of white oak on detritus of low, level hill-top.)

TABLE No. 13.

Barometric height.	Location.	Formation.	Timbers.
1600 feet.	Base of "Town Hill," one and three fourths mile from Jackson.	Coal-measures.	Liriodendron, white oak, white and shag hickory, linden, umbrella tree, water beech, red maple, redbud, beech, dogwood, sour-wood, and amelanchier.
1640 feet.	Hill-side.	Same.	Beeches end. Other timbers same.
1690 feet.	Hill-side.	Same.	Spanish oak, red oak, black oak, black hickory, pig hickory, and one or two white oaks.
1750 feet.	Hill-side.	Same.	Red oak, black oak, chestnut, mountain chestnut oak, black locust, black gum, scarlet oak, and pine (*rigida*).
1835 feet.	Hill-top.	Same.	Black oak, red oak, chestnut, mountain chestnut oak, mountain maple, sour-wood, dogwood, &c.

TABLE No. 14.

1530 ft. (N. W. F.)	Foot-hill on Troublesome Creek, twenty-one miles from Hazard.	Coal-measure Sandstone.	Sycamore, beech, linden, sugar maple, white elm, gray birch, big buckeye, papaw, liriodendron, rich red oak, amelanchier, golden Alexander, spicewood, magnolia (*Frazeri*), and dogwood.
1620 feet.	Dark, rich hill-side.	Same.	Nearly all beeches; some large liriodendron, blue ash, black gum, sugar maple, and small cornel.
1690 feet.	Same.	Same.	White oak, beeches, black gum, cornel bushes, and golden Alexander.
1740 feet.	Bench of hill.	Same.	White oak, white hickory, black gum, sugar maple, and beeches, the latter forming 80 per cent. of timbers.
1780 feet.	Hill-side.	Same.	Beeches (50 per cent.), chestnut, white oak, black gum, sour-wood, dogwood, huckleberry, and golden Alexander.
1840 feet.	Hill-side.	Same.	Chestnut, black birch, rock maple, beech, kalmia, sour-wood, and dogwood.
1875 feet.	Hill-side.	Same.	Chestnut, red oak, black oak, thin-bark hickory, mountain maple, mountain chestnut oak, sour-wood, and amalanchier.
1920 feet.	Rocky bluff.	Same.	Mountain chestnut oak, dwarf chestnut, rock maple, kalmia, amelanchier, and sour-wood.
1975 feet.	Hill-top.	Same.	Gray birch, mountain maple, and sour-wood.

TABLE No. 15.

Barometric height	Location.	Formation.	Timbers.
1975 ft. (S. E. F.)	Opposite face of preceding hill—hill-top.	Coal-measure Sandstone.	Timbers last given.
1925 feet	Hill-side.	Same.	Splendid pig hickory, black oak, black locust, red oak, mountain chestnut oak, mountain maple, and dogwood.
1900 feet.	Hill-side.	Same.	Liriodendron begins. Black walnut, linden, red mulberry, red oak, black oak, and gray birch.
1860 feet.	Hill-side.	Same.	Beeches begin. Mountain chestnut oak ends. In addition to beeches, sugar trees, liriodendron, and linden are found.
1775 feet	Hill-side.	Same.	Splendid liriodendron, white oak, big buckeye, sugar trees, red oak, and gray birch.
1680 feet	Hill-side.	Same.	Umbrella and beeches (the latter forming 90 per cent. of timbers).
1524 feet.	Foot-hill.	Same.	Same as foot-hill timbers on opposite side of hill.

TABLE No. 16.

1560 feet. (N. F.)	Foot-hill on Lost Creek, fourteen miles from Hazard.	Coal-measure Sandstone.	Hemlock, chestnut, red maple, white oak, water beech, beech, linden, black gum, gray birch, alder, spicewood, dogwood, sour-wood, and magnolia.
1605 feet.	Hill-side.	Same.	White oak, magnolia, water beech, white maple, black gum, gray birch, spicewood, and dogwood.
1655 feet.	Hill-side.	Same.	Linden, white oak, chestnut, gray birch, water beech, rock maple, red oak, amelanchier, sour-wood, and dogwood.
1705 feet.	Hill-side.	Same.	Splendid chestnut belt, pig hickory, black oak, black hickory, a few white oaks, gray birch, mountain chestnut oak, sour-wood, dogwood, and golden Alexander.
1760 feet.	Hill-side.	Same.	Chestnut, red oak, black gum, gray birch, black locust, mountain maple, mountain chestnut oak, and huckleberry.
1825 feet.	Bend of hill.	Same.	White oak (small amount), chestnut, black oak, mountain chestnut oak, beech, sour-wood, dogwood, sassafras, and amelanchier.
1925 feet.	Hill-top.	Same.	Red oak, black gum, thin-bark hickory, chestnut, and mountain chestnut oak.

TABLE No. 17.

Barometric height.	Location.	Formation.	Timbers.
1880 feet.	Base of hill, starting over from head waters of Lost to those of Lot s Creek, six miles from Hazard.	Coal-measures.	Splendid liriodendron, white oak, chestnut, beeches, black and blue ash, rich red oak, sugar maple, black birch, white and pig hickory, white maple, magnolia (umbrella, cucumber, and auriculata), hemlock, and dogwood
2040 feet.	Top of divide—low gap.	Same.	Chestnut, liriodendron, white oak, white hickory, black and gray birch, black oak, black hickory, dogwood, and sour-wood.
2120 feet	Hill-bench.	Same.	Red oak black oak, black gum mountain chestnut oak. pine (*rigida*), and kalmia.
2180 feet	Hill-side.	Same.	Black-jack, scrub oak, and pine (*rigida*).
2225 feet.	Top of Sandstone bluff.	Same.	Pine (*mitis*), scrub black oak, and scrub red oak (*ilicifolia*).
2265 feet.	Hill-top	Same.	Pine, scrub chestnut, and mountain chestnut oak.

TABLE No. 18.

Barometric height.	Location.	Formation.	Timbers.
1700 feet (N. F.)	Base of rich hill, with three veins of coal, five miles from Hazard.	Coal-measures	White oak, liriodendron beeches (50 per cent. of timbers), linden, black ash. box-elder, swamp chestnut oak, white ash, white and black hickory, magnolia, white walnut, red oak, buckeye, water beech, papaw, and spicewood.
1825 feet.	Hill-side.	Same.	Splendid blue ash. white oak, liriodendron, shag hickory, gray birch, water beech, sugar maple, black gum, hazelnut, golden Alexander, and dogwood.
2020 feet.	Hill-side.	Same.	Liriodendron, chestnut, black oak, hickories, &c. Not much change from last timbers.
2220 feet.	Hill-side.	Same.	Magnificent forest of liriodendron, linden, black and blue ash, black hickory black walnut (not large), sugar maple. birch, swamp chestnut oak, rich red oak, redbud, spicewood, papaw, and dogwood.
2300 feet.	Base of bluff.	Same.	Liriodendron, chestnut, linden, blue ash, rich red oak, black locust, dogwood.
2375 feet.	Hill-side.	Same.	Mountain chestnut oak, black oak. scrub white hickory, mountain maple, Amelanchier, dogwood, sour-wood, and huckleberry.
2425 feet.	Hill-side.	Same.	Pine (*rigida*), huckleberry, and Kalmia.
2500 feet.	Hill-top.	Same.	Pine (*rigida*), red oak, mountain maple, huckleberry, and kalmia.

TABLE No. 19.

Barometric height.	Location.	Formation.	Timbers.
1920 ft. (S. S. W. F)	Base of divide between Breeding's Creek and Rockhouse Creek, thirteen miles from Whitesburg.	Coal-measures.	Beeches, white oak, liriodendron, white and black walnut, big buckeye, rich red oak, linden, water beech, magnolia, winged and red elm. black ash, white hickory, willows, dogwood, and sour-wood.
1980 feet.	Hill-side.	Coal-measures.	Beeches, gray birch, liriodendron, black gum, linden, buckeye, white walnut. magnolia, and dogwood.
2050 feet.	Same, near head of branch under brow of hill.	Coal-measures.	Magnificent liriodendron, blue ash, white hickory, shag hickory, chestnut, sugar maple, beeches. mulberry, rich red oak, buckeye, water beech, dogwood, and papaw.
2180 feet.	Hill-side.	Coal-measures.	Belt of white oak, with black oak, chestnut, hickory, magnolia, dogwood. amelanchier, sour-wood, and sassafras.
2250 feet.	Hill-side.	Coal-measures.	Chestnut, black locust, iron-wood, rock maple, black gum, amelanchier, sour-wood, and dogwood.
2290 feet.	Broken Sandstone bluff.	Coal-measures.	Mountain chestnut oak, chestnut, kalmia, dogwood, and sour-wood.
2340 feet.	Top of bluff.	Coal-measures.	Mostly pines (*rigida and mitis*), since last level. Here, chestnut, scrub white hickory, black oak, rock maple, scrub post oak, black sumach, amelanchier, sour-wood, and dogwood.
2355 feet.	Hill-side.	Same—shaly Sandstone.	Thicket of post oaks, with scrub white hickory, mountain ash, black locust, and mountain chestnut oak.
2400 feet.	Base of bluff.	Massive Sandstone.	Only mountain chestnut oak trees, with small growth same as at 2340 level.
2500 feet.	Hill-top.	Coal-measures.	Chestnut, mountain chestnut oak, black locust, scrub red and black oak, scrub hickory, dogwood, and sassafras.

TABLE No. 20.

Barometric height.	Location.	Formation.	Timbers.
2120 feet.	Base of divide, between Kolley's Branch and Sandy Lick, seven miles from Whitesburg.	Coal-measures.	Splendid white oak, liriodendron, white hickory, beeches, black gum, sugar maple, big buckeye, linden, black ash, mulberry, rich red oak, gray birch, magnolia (cucumber), and papaw.
2250 feet.	Hill-side.	Same.	Chestnut red maple, rock maple, beeches, sour-wood, dogwood, and sassafras. (I was unable to go higher on this hill. The top would be about 2400 feet.)

TABLE No. 21.

2230 feet.	Base of Pine Mountain, starting through Pound Gap.	Coal-measures.	White oak, liriodendron, linden (American and Canadian), chestnut, rich red oak, hemlock, beeches, magnolias, black and blue ash, gray and black birch, red maple, black gum, buckeye, dogwood, and sour-wood.
2475 feet.	Mountain-side, one mile from Pound Gap.	Line of Pine Mountain fault. Devonian Shale.	Mountain chestnut oak, chestnut, beech, gray birch, scrub oak, red oak, magnolia, mountain maple, white walnut, shag hickory, liriodendron, white oak, black gum, linden, and wintergreen. (Note.—We pass almost immediately from Devonian Shale onto Keokuk, and there is little perceptible change in the timbers.)
2560 feet.	Mountain-side.	Keokuk Limestone.	Magnificent liriodendron, chestnut, linden, ashes, buckeye, rich red oak, white hickory, black walnut; some white oak, sugar trees, black locust, black birch, magnolia, mountain chestnut oak, water beech, and papaw.
2700 feet.	Mountain-side	Saint Louis Limestone.	Linden, white hickory, liriodendron, pig hickory, red oak, buckeye, black locust, gray birch, and mountain chestnut oak. (Note.—Absence of chestnut.)
2800 feet.	Mountain-side.	Chester Sandstone.	Chestnut, white walnut, linden, black oak, sugar trees, shellbark hickory, and mountain chestnut oak.
2870 feet.	Bluff.	Same.	Mountain chestnut oak, mountain maple, magnolia, gray and spotted birch, black locust, scrub oak, scrub chestnut, rhododendron and kalmia, dogwood, and sour-wood.
2925 feet.	Mountain-side.	Very micaceous Sandstone. Conglomerate (?)	Chestnut, mountain chestnut oak, black and blue ash (not large), black locust, linden, mountain maple, magnolia, and white walnut.
3100 feet.	Pound Gap—top of divide.	Conglomerate Sandstone.	Chestnut, red oak, black locust, white walnut, mountain chestnut oak, pith elder, white and black sumach, sassafras, dogwood, and sour-wood
3260 feet.	Peak to right of gap, going south.	Conglomerate.	Small shell-bark hickory, chestnut, mountain chestnut oak, scrub oak, spotted birch, dwarf black hickory, mountain hazelnut, huckleberry, and sassafras.
3410 feet.	Top of peak.	Same.	Shell-bark hickory, mountain chestnut oak, gray birch, linden (small), black locust, white walnut black oak, scrub oak, scrub white oak (only one), chestnut spotted birch, sassafras, and sour-wood. (Note.—On the opposite (southeast) face of the mountain there is a great deal of pine, but no other material difference in the timbers.)

From the foregoing tables, taken from different parts of the forests throughout the entire length of the State, and, therefore, as general as it is possible to obtain them, much information can be obtained as to the effect of height above drainage on Kentucky timbers. For instance, let us take white oak and go through the various tables. The following is the result:

Timbers.	Height of hill in feet.	Height to which white oak grows	Proportion of height to which white oak grows to entire height of hill.	Formation.
White oak . .	135	40	30—	Silicious Limestone.
White oak . .	185	130	70+	Silicious Limestone.
White oak . .	163	75	46+	St. Louis Limestone.
White oak . .	173	68	35+	St. Louis Limestone.
White oak . .	150	150	100	Keokuk Limestone.
White oak . .	600	275	46+	Keokuk Limestone.
White oak . .	330	130	39+	Cincinnati Limestone.
White oak . .	235	100	43—	Devonian Shale and Candigalli.
White oak . .	435	230	53—	Candigalli.
White oak . .	85	60	71—	Conglomerate Sandstone.
White oak . .	135	135	100	Coal-measures.
White oak . .	235	90	38+	Coal-measures.
White oak . .	445	250	56+	Coal-measures.
White oak . .	401	251	63—	Coal-measures.
White oak . .	365	265	73—	Coal-measures.
White oak . .	385	150	40+	Coal-measures.
White oak . .	800	520	65	Coal-measures.
White oak . .	580	260	45—	Coal-measures.
White oak . .	1030	336	32+	Coal-measures.

From this table can readily be deduced the average height of all the hills in Kentucky selected for these experiments, the average height above drainage to which white oak grows, and the relation that the latter height bears to the entire height of the hill. The following table shows these deductions:

Timbers.	Average height of hill.	Average height on hill to which white oak grows.	Proportion of latter to former.
White oak	308.8	184.7	60 nearly.

In other words, throughout the forests of Kentucky the white oak extends, on a general average, over sixty per cent. of the

hills. A slight examination will also show that on Keokuk limestone white oak extends to seventy-three per cent. of the total height of the hills; on Conglomerate sandstone, to seventy-one per cent.; on coal-measures, to fifty-seven per cent.; on silicious limestone, to fifty per cent.; and on St. Louis limestone, to forty per cent. This indicates that Keokuk, leaving out the Keokuk shales, is the richest of the formations in white oak growth.

In the same way it may be shown, from the general tables, that liriodendron extends to an average of forty-five per cent. of the total heights of hills, or not quite half way. The reader can easily make deductions for all other timbers. It will be noticed that there is no general and definite relation existing between the height of hills and the height to which any particular timber will grow. Everything depends upon the nature of the hill, and upon whether the formation is adapted to retaining moisture. On a damp hill, though very high, a timber will be found, growing entirely to the top, which would not extend more than a few feet up another and drier hill. It is exceedingly interesting, though, to know the *average* height above drainage to which the principal forest trees extend; and that can be deduced from the tables given.

SUMMARY.

A brief review of the foregoing pages will show—

First. That changes in geological formation will produce immediate, and often exceedingly marked, effects upon the character of the timbers. Such changes are often noticed, in *shallow-rooted* timbers, before a change of formation is reached, owing to the effect of detritus from the neighboring formation. They may likewise be noticed in very *deep-rooted* timbers, for the opposite reason, that their roots extend down beneath the surface formation, and penetrate the underlying one, when that is not visible.

Second. That height above drainage always produces a marked effect upon timbers, whatever the formation; but that such effect is less in the case of a Keokuk limestone formation than in any other found in Kentucky.

Third. That there is no regular proportion between the total heights of hills and the heights to which particular timbers grow. Everything depends upon the nature of the formation.

Fourth. That of the marked difference in character between the forests of Eastern and those of Western Kentucky, only the distribution of the pines can be satisfactorily accounted for without further and special study in that direction.

LIST OF TIMBERS.

The following is a list of timbers met with and spoken of in this Report:

ORDER CUPULIFERÆ—MASTWORTS.

1. *Genus Quercus—oak.*
   - White oak, Quercus alba (L.)
   - Swamp white oak, Q. bicolor (Willd.)
   - Bartram oak, Q. heterophylla (Mx.)
   - Red oak, Q. rubra (L.)
   - Spanish oak, Q. falcata (L.)
   - Scarlet oak, Q. coccinea (Wang.)
   - Post oak, Q. obtusiloba (Mx.)
   - Rich red oak, Q. macrocarpa (Mx.)
   - Black oak, Q. tinctoria (Bart.)
   - Pin oak, Q. palustris (Mx.)
   - Laurel oak, Q. imbricaria (Mx.)
   - Swamp laurel oak, Q. laurifolia (Mx.)
   - Chestnut oak, Q. castanea (Muhl.)
   - Swamp chestnut oak, Q. prinus (Willd.)
   - Chinquapin oak, Q. prinoides (Willd.)
   - Black-jack, Q. nigra (L.)
   - Scrub oak, Q. ilicifolia (Willd.)

2. *Genus Castanea—chestnut.*
   - Common Chestnut, Castanea vesca (L.)
   - Chinquapin, Castanea pumila (Mx.)

3. *Genus Fagus—beech.*
   - Common beech, Fagus sylvatica (L.)
   - Red variety, Fagus ferruginea (Ait.)

4. *Genus Corylus—hazelnut.*
   - Common hazelnut, Corylus Americana (Walt.)

5. *Genus Ostrya—hop hornbeam.*
   - Common ironwood, Ostrya Virginica (Willd.)
   - Var. hornbeam, Carpinus Americana (L.)
   - (NOTE.—I prefer giving the latter as a mere variety of the former, rather than as a distinct *genus carpinus.*)

ORDER JUGLANDACEÆ.

1. *Genus Carya—hickory.*
   - Black hickory, Carya tomentosa (Nutt.)
   - White hickory, Carya microcarpa (Nutt.)
   - Shag hickory, Carya alba (Nutt.)
   - Shellbark hickory, Carya sulcata (Nutt.)
   - Pig hickory, Carya glabra (Torr.)

2. *Genus Juglans—walnut.*
   - Black walnut, Juglans nigra (L.)
   - White walnut, Juglans cinerea (L.)

ORDER BETULACEÆ.

1. *Genus Betula—birch.*
   - Black birch, Betula lenta (L.)
   - Red birch, Betula nigra (Ait.)
   - Yellow birch, Betula excelsa (Ait.)
   - Spotted birch, Betula pumila (L.)

2. *Genus Alnus—alder.*
   - Swamp alder, Alnus serrulata (Willd.)

ORDER ACERACEÆ.

1. *Genus Acer—maple.*
   - White maple, Acer dasycarpum (Ehr.)
   - Black maple, Acer nigrum (Mx.)
   - Red maple, Acer rubrum (L.)
   - Same, Var. tridens.
   - Sugar maple, Acer saccharinum (L.)
   - Mountain maple, Acer spicatum (Lam.)

2. *Genus Negundo.*
   - Box-elder, Negundo aceroides (Moench)

ORDER CONIFERÆ.

1. *Genus Pinus—pine.*
   Yellow pine, Pinus mitis (Mx.)
   Pitch pine, Pinus rigida (Miller.)
   Loblolly pine, Pinus taeda (L.)
   White pine, Pinus strobus (L.)
   Mountain pine, Pinus pungens (Mx.)
2. *Genus Abies.*
   Hemlock, Abies canadensis (Mx.)
3. *Genus Taxodium.*
   Bald cypress, Taxodium distychum (Rich.)
4. *Genus Juniperus.*
   Common cedar, Juniperus Virginiana.

ORDER ULMACEÆ.

1. *Genus Ulmus—elm.*
   Red elm, Ulmus fulva (L.)
   Winged elm, Ulmus alata (Mx.)
   Cork elm, Ulmus racemosa (Thomas.)
   White elm, Ulmus Americana (L.)
2. *Genus Celtis.*
   Hackberry, Celtis occidentalis (L.)

ORDER ROSACEÆ.

1. *Genus Cerasus—cherry.*
   Black cherry, Cerasus serotina (D. C.)
2. *Genus Prinus—plum.*
   Common plum, Prinus Americana (Marsh.)
3. *Genus Cratægus—thorn.*
   Black thorn, Cratægus tomentosa (L.)
   Yellow thorn, Cratægus punctata (Jacq.)
   Hawthorn, Cratægus oxycantha (L.)
4. *Genus Amelanchier.*
   Service berry, Amelanchier canadensis (T. & G.)
   Same, shrub, Var. oblongifolia (T. & G.)
5. *Genus Spiræ.*
   Ninebark, Spiræ opulifolia (L.)
   Mountain spiræ, Spiræ corymbosa (Raf.)

ORDER OLEACEÆ.

1. *Genus Fraxinus—ash.*
   Black ash, Fraxinus sambucifolia (Lam.)
   Blue ash, Fraxinus quadrangulata (Mx.)
   White ash, Fraxinus Americana (L.)
   Green ash, Fraxinus viridis (Mx.)

ORDER MAGNOLIACEÆ.

1. *Genus Magnolia.*
   Big laurel, Magnolia grandiflora (L.)
   Cucumber tree, Magnolia acuminata (L.)
   Umbrella tree, Magnolia umbrella (Lam.)
   Big-leafed magnolia, Magnolia macrophylla (Mx.)
   Ear-shaped magnolia, Magnolia Fraseri (Walt.)
2. *Genus Liriodendron.*
   Tulip tree (yellow poplar), Liriodendron tulipfera (L.)

ORDER TILIACEÆ.

1. *Genus Tilia—linden tree.*
   American basswood, Tilia Americana (L.)
   Canadian or white basswood, Tilia heterophylla.
   Canadian or white basswood, Var. alba (Vent.)

ORDER ERICACEÆ.

1. *Genus Kalmia.*
   Spoon-wood, Kalmia latifolia (L.)
2. *Genus Gaultheria.*
   Wintergreen, Gaultheria procumbens (L.)
3. *Genus Vaccinium.*
   Blueberry, Vaccinium corymbosum (L.)
4. *Genus Oxydendrum.*
   Sorrel tree, Oxydendrum arboreum (D. C.)
5. *Genus Azalea.*
   White azalea, Azalea viscosa (L.)
   Pinxter-bloom, Azalea nudiflora (L.)
   Tree azalea, Azalea arborescens (Ph.)

6. *Genus Rhododendron.*
   Large rhododendron, Rhododendron maximum (L.)
7. *Genus Clethra.*
   Sweet pepper, Clethra alnifolia (L.)

ORDER SALICACEÆ.

1. *Genus Populus.*
   Cotton tree, Populus Angulata (Ait.)
   Aspen, Populus tremuloides (Mx.)
   Balm of Gilead, Populus candicans (Ait.)
   Silver-leafed poplar, Populus alba (L.)

ORDER LEGUMINOSÆ.

1. *Genus Gymnocladus.*
   Coffee tree, Gymnocladus canadensis (Lam.)
2. *Genus Gleditschia.*
   Honey locust, Gleditschia triacanthus (L.)
3. *Genus Robinia.*
   Black locust, Robinia pseudacacia (L.)
4. *Genus Cercis.*
   Redbud, Cercis canadensis (L.)
5. *Genus Cladastris.*
   Yellow wood, Cladastris tinctoria (Raf.)

ORDER CORNACEÆ.

1. *Genus Nyssa.*
   Black gum, Nyssa multiflora (Wang.)
   Swamp black gum, Nyssa uniflora (Wang.)
2. *Genus Cornus.*
   Common dogwood, Cornus florida (L.)
   Yellow dogwood, Cornus sericea (L.)
   Green cornel, Cornus alternifolia (L.)

ORDER SAPINDACEÆ.

1. *Genus Æsculus.*
   Big buckeye, Æsculus flava (Ait.)
   Small buckeye, Æsculus pavia (L.)

ORDER HAMAMELACEÆ.

1. *Genus Liquidamber.*
   Sweet gum, Liquidamber styraciflua (L.)
1. *Genus Hamamelis.*
   Witch hazel, Hamamelis Virginiana (L.)

ORDER ANACARDIACEÆ.

1. *Genus Rhus—sumach.*
   Smooth sumach, Rhus glabra (L.)
   Large sumach, Rhus typhina (L.)
   Mountain sumach, Rhus copallina (L.)
   Poison oak (sumach), Rhus toxicodendron (L.)

ORDER AQUIFOLIACEÆ.

1. *Genus Ilex.*
   Holly, Ilex opaca (L).

ORDER CAPRIFOLIACEÆ.

1. *Genus Sambucus.*
   Pith elder, Sambucus canadensis (L.)
2. *Genus Liburnum.*
   Black haw, Liburnum prunifolium (L.)

ORDER ARTOCARPACEÆ.

1. *Genus Morus.*
   Red mulberry, Morus rubra (L.)

ORDER PLATANACEÆ.

1. *Genus Platanus.*
   Sycamore, Platanus occidentalis (L.)

ORDER RUTACEÆ.

1. *Genus Xanthoxylum.*
   Prickly ash, Xanthoxylum Americanum (Miller.)
2. *Genus Ailanthus.*
   Tree of heaven, Ailanthus glandulosa (Desf.)

ORDER BIGNONIACEÆ.

1. *Genus Catalpa.*
   Catalpa, Catalpa bignonioides (Walt.)

ORDER LAURACEÆ.

1. *Genus Benzoin.*
   Spicewood, Benzoin odoriferum (Nees.)
2. *Genus Sassafras.*
   Common sassafras, Sassafras officinale (Nees.)

ORDER ANONACEÆ.

1. *Genus Asimina.*
   Papaw, Asimina triloba (Dunal.)
   Same, Asimina parviflora(?) (Dunal.)

ORDER CALYCANTHACEÆ.

1. *Genus Calycanthus.*
   Sweet shrub, Calycanthus floridus (L.)

ORDER EBENACEÆ.

1. *Genus Diospyros.*
   Persimmon, Diospyros Virginiana (L.)

ORDER CELASTRACEÆ.

1. *Genus Enonymus.*
   Burning bush, Enonymus Americanus (L.)

ORDER UMBELLIFERÆ.

1. *Genus Thaspium.*
   Golden Alexander, Thaspium cordatum (Nutt.)

ORDER CAMELLIACEÆ.

1. *Genus Stuartia.*
   Stuartia, Stuartia Virginica (Cav.)

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